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(71)出願人 000000527

旭光学工業株式会社

東京都板橋区前野町2丁目36番9号

(72)発明者 伊藤 栄一

東京都板橋区前野町2丁目36番9号 旭光学工業株式会社内

(74)代理人 100098235

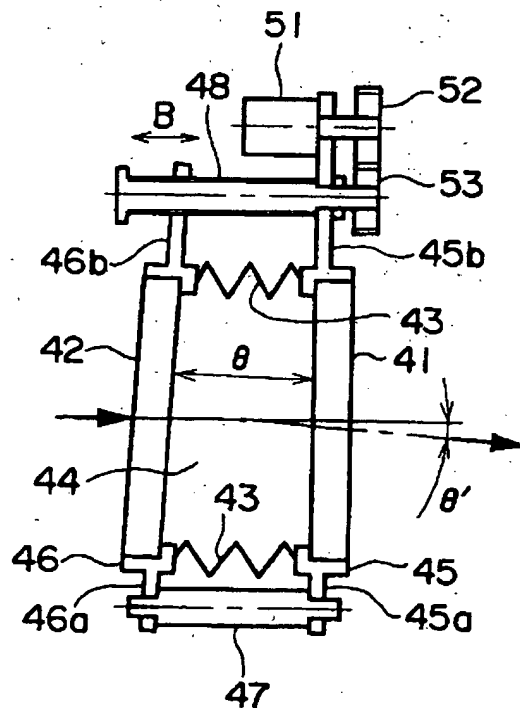
弁理士 金井 英幸

(54)【発明の名称】 レーザ測量装置

(57)【要約】

【課題】 整準のための構造を簡単にすることができ、しかも整準作業を短時間で行うことができるレーザ測量装置を提供する。

【解決手段】 弾性体からなる蛇腹状のカバー43は、2枚の略平行ガラス41、42によって封止されており、カバー43内部は液層44が充填されている。略平行ガラス42を保持するガラス押さえ枠46に形成されたリードネジ保持部46bは、リードネジ48に螺合している。モータ51が回転されることにより、リードネジ48が回転し、これに伴い、リードネジ保持部46bが図中B方向に進退移動される。これによって、液層44の頂角 $\theta$ の大きさが変化し、2枚の略平行ガラス41、42を透過するレーザビームのビーム軸の向きは、この頂角 $\theta$ の大きさに応じて屈折される。



## 【特許請求の範囲】

## 【請求項 1】 レーザ光源と、

前記レーザ光源から出射されたレーザビームの光路上に配置された略平板状の第 1 および第 2 透明部材と、

前記第 1 および第 2 透明部材によってその両開口縁が封止された筒状の弾性部材と、

前記弾性部材内に液体が充填されることにより形成された液層と、

前記第 1 および第 2 透明部材を保持する鏡筒と、

この鏡筒に保持された前記第 1 および第 2 透明部材の相対的傾斜角を、平行を含む範囲で調整可能とする調整機構と、

前記鏡筒の水平面に対する傾斜角を検出するレベル検知器と、

前記レベル検知器によって検出された前記傾斜角の大きさに応じて前記調整機構を制御し、前記第 1 透明部材と前記第 2 透明部材のなす角の大きさを調整する制御手段とを備えるレーザ測量装置。

【請求項 2】 前記弾性部材は蛇腹状の形状を有している請求項 1 記載のレーザ測量装置。

【請求項 3】 前記液層を形成する液体はシリコンオイルである請求項 1 記載のレーザ測量装置

【請求項 4】 前記第 1 および第 2 透明部材を透過したレーザビームを  $90^\circ$  偏向する反射部材と、

前記反射部材を回転させることによりこの反射部材によって偏向されたレーザビームの出射方向を一定平面内で回転させる回転手段とをさらに備える請求項 1 ないし請求項 3 のいずれかに記載のレーザ測量装置。

【請求項 5】 前記レーザ光源から出射されたレーザビームを 2 以上のレーザビームに分割するビーム分割手段と、前記ビーム分割手段によって分割されたレーザビームのうちの 1 つを集光する集光レンズと、前記集光レンズの焦点面上に配置され、前記集光レンズによって集光されたレーザビームの入射位置を検知する光位置検出手段とをさらに備え、

前記制御手段は前記第 1 透明部材と前記第 2 透明部材のなす角の大きさを前記光位置検出手段に入射した前記レーザビームの入射位置の変化量に基づいて算出する請求項 1 ないし請求項 3 のいずれかに記載のレーザ測量装置。

【請求項 6】 レーザ光源と、

このレーザビームのビーム軸を中心として回転可能に鏡筒内に保持されるとともに前記レーザ光源から出射されたレーザビームを透過する第 1 楔ガラスと、

前記レーザビームのビーム軸を中心として回転可能に鏡筒内に保持されるとともに前記第 1 楔ガラスを透過したレーザビームを透過する第 2 楔ガラスと、

前記鏡筒に保持された前記第 1 および第 2 楔ガラスを回転させる回転機構と、

前記鏡筒の水平面に対する傾斜角を検出するレベル検知

器と、

前記レベル検知器によって検出された前記傾斜角の大きさに応じて前記回転機構を制御し、前記第 1 および第 2 楔ガラスを透過するレーザビームの出射方向を調整する制御手段とを備えるレーザ測量装置。

【請求項 7】 前記第 1 および第 2 楔ガラスを透過したレーザビームを  $90^\circ$  偏向する反射部材と、

前記反射部材を回転させることによりこの反射部材によって偏向されたレーザビームの出射方向を一定平面内で回転させる回転手段とをさらに備える請求項 6 記載のレーザ測量装置。

【請求項 8】 前記レーザ光源から出射されたレーザビームを 2 以上のレーザビームに分割するビーム分割手段と、前記ビーム分割手段によって分割されたレーザビームのうちの 1 つを集光する集光レンズと、前記集光レンズの焦点面上に配置され、前記集光レンズによって集光されたレーザビームの入射位置を検知する光位置検出手段とをさらに備え、

前記制御手段は前記第 1 および第 2 楔ガラスの回転を前記光位置検出手段に入射した前記レーザビームの入射位置の変化量に応じて制御する請求項 6 記載のレーザ測量装置。

【請求項 9】 前記ビーム分割手段は入射光の一部を透過するとともに残りを反射するビームスプリッタである請求項 5 または請求項 8 に記載のレーザ測量装置。

【請求項 10】 前記光位置検出手段は 2 次元ポジション・センシティブ・ディテクタ (PSD) である請求項 5 または請求項 8 に記載のレーザ測量装置。

【請求項 11】 前記ビーム分割手段によって分割されたレーザビームの他の 1 つを  $90^\circ$  偏向する反射部材と、前記反射部材を回転させることによりこの反射部材によって偏向されたレーザビームの出射方向を一定平面内で回転させる回転手段とをさらに備える請求項 5 または請求項 8 に記載のレーザ測量装置。

【請求項 12】 前記反射部材はペンタプリズムである請求項 4、7、11 のいずれかに記載のレーザ測量装置。

【請求項 13】 前記レベル検知器によって検出される傾斜角は前記ビーム分割手段によって分割されて前記反射部材に入射するレーザビームのビーム軸の鉛直に対する傾きに対応する請求項 4、7、11、12 のいずれかに記載のレーザ測量装置。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は、レーザビームによる基準線を所定の面に対して水平方向または垂直方向に投射するレーザ測量装置に関する。

## 【0002】

【従来の技術】 従来より、土木、建築などの分野では、水平線や垂直線の墨出しを行うためのレーザ測量装置（いわゆるレーザプレーナ）が使用されている。このレ

ーザ装置はレーザー光を出射する投光部を回転させてこのレーザー光を周方向に走査し、レーザー光の軌跡によって壁面などの被投射面に垂直または水平方向の基準線を投射するものである。

【0003】図12は、従来のレーザー測量装置の構成を示す断面図である。この図12は、水平方向へのレーザー光走査を行うためにレーザー測量装置を鉛直方向に立てた状態を示している。ハウジング81内に納められた鏡筒82は、レーザー測量装置の中心軸に沿ってその全体を貫通する中空のレーザー光光路82bとこのレーザー光光路82bから直角に分岐した中空のレーザー光光路82aとから構成されている。レーザー光光路82a内には、その端面側からレーザーダイオード83、コリメータレンズユニット104、アナモプリズム84が固定されている。そして、レーザー光光路82aおよび82bの交点には、直角プリズム85が固定されている。

【0004】レーザー光光路82b内には、図12において直角プリズム85から上方に向かって、前群レンズ86および後群レンズ87が固定されている。鏡筒82の上端部には、ペンタプリズム89が納められた略円筒状の回転投光部88が、レーザー光光路82bに直交する面内で回転自在に固定されている。この回転投光部88の上端面および側方には、それぞれ開口部が形成されている。

【0005】このような構成のレーザー測量装置において、レーザー光光路82a端面に固定されたレーザーダイオード83からレーザービームL<sub>11</sub>が出射されると、そのレーザービームL<sub>11</sub>は直角プリズム85において回転投光部88側に90°屈曲され、前群レンズ86および後群レンズ87を透過してペンタプリズム89に入射する。ペンタプリズム89に入射したレーザービームL<sub>11</sub>は、第1反射面89aおよびこの第1反射面に対して45°傾いた第2反射面89bによって漸次反射される。そして、第1反射面89aおよび第2反射面89bで反射されたレーザービームL<sub>11</sub>は、光入射面89dに対して直角をなしている光射出面89cから出射される。

【0006】また、第1反射面89aには部分反射膜が形成されている。従って、一部のレーザービームL<sub>11</sub>がこの第1反射面89aを透過し、この第1反射面89a上に固定された楔形プリズム90を透過して回転投光部88上端面の開口部から出射される。

【0007】そして、回転投光部88がレーザー光光路82bに直交する面内で回転することにより、レーザービームL<sub>11</sub>は、回転投光部88の回転軸を中心に回転する。従って、この回転軸に直交する基準平面がレーザービームL<sub>11</sub>により形成される。また、回転投光部88の上端から出射されるレーザービームL<sub>11</sub>は天井などに測量基準点などを示すための基準スポットを形成する。

【0008】このように、レーザー測量装置から出射されたレーザービームL<sub>11</sub>は、壁面などに基準平面を形成する

ため、正確に水平に出射される必要がある。同様に、天井等に基準スポットを形成するレーザービームL<sub>11</sub>も正確に鉛直に出射される必要がある。よって、レーザー測量装置の使用時には、レーザービームL<sub>11</sub>が正確に水平方向に出射されるように、整準作業を行う必要がある。

【0009】以下、レーザービームL<sub>11</sub>が正確に水平に出射されるための整準機構を説明する。鏡筒82の上端側には、半球面形状を有する膨出部91が形成されており、ハウジング81内に形成された摺動孔81a内に当接した状態で保持されている。鏡筒82のハウジング81に対する保持は、この部分の接触によってのみなされているので、摺動孔81a内で膨出部91の半球面部分を回転させることにより、鏡筒82全体をあらゆる方向に傾動させることができる。

【0010】また、ハウジング81内には、レベル調整用モータ98によって回転されるスクリュー97が設けられている。このスクリュー97には、ナット99が螺合されている。このナット99はスクリュー97の回転に伴って上下動される。ナット99の外面には、作動ピン101が突出形成されている。作動ピン101には膨出部91に形成された駆動アーム96と連通するピン100が接触しており、これにより、膨出部91のX方向（紙面内での回転方向）の回転が規制されている。

【0011】さらに、鏡筒82内において直角プリズム85の下方には、鏡筒82のX方向の傾きを検出するX方向のチルトセンサ103が固定されている。このチルトセンサ103によって検知された傾きに応じてレベル調整用モータ98の回転制御が行われ、これによって、スクリュー97が回転される。するとこのスクリュー97の回転に伴ってナット99が上下動され、作動ピン101およびピン100を介してリンクされた膨出部91が、X方向に回転される。なお、X方向のチルトセンサの側方には、Y方向（図面中鉛直方向に沿って紙面に直交する面内での回転方向）の傾きを検出するY方向のチルトセンサ102が固定されている。また、図面中には示されていないが、ハウジング81内には、チルトセンサ102によって検出される傾きの大きさに応じて、膨出部91のY方向の回転を規制するための機構もX方向と同様に設けられている。このようにして、鏡筒82が常に鉛直方向を向くように、すなわち、レーザービームL<sub>11</sub>が常に水平に出射されるように調整される。従って、レーザービームL<sub>11</sub>は常に正確な基準面を形成することができる。

【0012】

【発明が解決しようとする課題】しかしながら、上述したような従来のレーザー測量装置の構造では、レーザービームL<sub>11</sub>を水平に出射させるための整準作業は、レベル調整用モータ98やスクリュー97、ナット99等を用いて鏡筒82を傾けることにより行われている。このために、レーザー測量装置の構造が複雑になってしまうという

問題があった。

【0013】また、チルトセンサ102、103は傾き  
が変化すると、その測定値が計測可能に安定するまで一  
定の時間がかかる。このため、従来のように鏡筒82を  
傾けることによる調整を行った場合、鏡筒82の傾きが  
変化する度にチルトセンサ102、103の測定値が安  
定するのを待たなければならない。このため、整準作業  
を行うために長時間を要していた。

【0014】そこで、整準のための構造を簡単にするこ  
とができ、しかも整準作業を短時間で行うことができる  
レーザ測量装置を提供することを、本発明の課題とす  
る。

【0015】

【課題を解決するための手段】上記課題を解決するた  
め、本発明のレーザ測量装置の第1の態様は、レーザ光  
源と、前記レーザ光源から出射されたレーザビームの光  
路上に配置された略平板状の第1および第2透明部材  
と、前記第1および第2透明部材によってその両開口縁  
が封止された筒状の弾性部材と、前記弾性部材内に液体  
が充填されることにより形成された液層と、前記第1お  
よび第2透明部材を保持する鏡筒と、この鏡筒に保持さ  
れた前記第1および第2透明部材の相対的傾斜角を、平  
行を含む範囲で調整可能とする調整機構と、前記鏡筒の  
水平面に対する傾斜角を検出するレベル検知器と、前記  
レベル検知器によって検出された前記傾斜角の大きさに  
応じて前記調整機構を制御し、前記第1透明部材と前記  
第2透明部材のなす角の大きさを調整する制御手段とを  
備える。

【0016】すなわち、第1態様のレーザ測量装置で  
は、弾性部材を第1および第2の透明部材によって封止  
してその中に液体を充填したユニットを、レーザビーム  
の光路上に配置している。そして、レベル検知器によ  
って検出された鏡筒の水平からの傾きの大きさに応じて、  
各透明部材のなす角を変化させることによって、これら  
各透明部材を透過するビーム軸の向きを変化させてい  
る。従って、従来のように、鏡筒を傾ける複雑な整準機  
構を設ける必要がないため、レーザ測量装置の構造を簡  
素化することができる。また、第1態様のレーザ測量装  
置では、各透明部材のなす角の大きさを変化させること  
によってのみビーム軸の向きを調整しているので、鏡筒  
全体の向きを変える必要がない。よって、レベル検知器  
の測定値は整準作業を通じて常に一定であるので、従来  
のように、整準作業を行う際にレベル検知器の測定値が  
安定するまでの時間を要しない。よって、整準作業の時  
間を短縮することができる。

【0017】このような構成のレーザ測量装置を用いる  
際には、前記弾性部材を蛇腹状の形状を有するものと  
してもよいし、前記液層を形成する液体をシリコンオイル  
としてもよい。

【0018】また、上記構成のレーザ測量装置は、前記

第1および第2透明部材を透過したレーザビームを90  
° 偏向する反射部材と、前記反射部材を回転させること  
によりこの反射部材によって偏向されたレーザビームの  
出射方向を一定平面内で回転させる回転手段とをさらに  
備えるものであってもよい。

【0019】さらに、上記構成のレーザ測量装置は、前  
記レーザ光源から出射されたレーザビームを2以上のレー  
ザビームに分割するビーム分割手段と、前記ビーム分  
割手段によって分割されたレーザビームのうちの1つを  
集光する集光レンズと、前記集光レンズの焦点面上に配  
置され、前記集光レンズによって集光されたレーザビー  
ムの入射位置を検知する光位置検出手段とをさらに備  
え、前記制御手段は前記第1透明部材と前記第2透明部  
材のなす角の大きさを前記光位置検出手段に入射した前  
記レーザビームの入射位置の変化量に基づいて算出する  
ものであってもよい。

【0020】このような構成のレーザ測量装置を採用す  
れば、各透明部材のなす角の大きさを、ビーム分割手段  
により分割されたビームの光位置検出素子への入射位置  
の変化量に対応させて検出することができる。よって、  
ビーム軸の向きをより精密に調整することができる。

【0021】また、本発明のレーザ測量装置の第2の態  
様は、レーザ光源と、このレーザビームのビーム軸を中  
心として回転可能に鏡筒内に保持されるとともに前記レー  
ザ光源から出射されたレーザビームを透過する第1楔  
ガラスと、前記レーザビームのビーム軸を中心として回  
転可能に鏡筒内に保持されるとともに前記第1楔ガラス  
を透過したレーザビームを透過する第2楔ガラスと、前  
記鏡筒内に保持された前記第1および第2楔ガラスを回  
転させる回転機構と、前記鏡筒の水平面に対する傾斜角  
を検出するレベル検知器と、前記レベル検知器によ  
って検出された前記傾斜角の大きさに応じて前記回転機構を  
制御し、前記第1および第2楔ガラスを透過するレーザ  
ビームの出射方向を調整する制御手段とを備える。

【0022】すなわち、第2態様のレーザ測量装置は、  
レーザビームの光路上に2枚の楔ガラスを配置し、各楔  
ガラスを当該レーザビームの光路に直交する面で回転  
することによりレーザビームのビーム軸の向きを調整  
することができる。これにより、第1態様と同様、レーザ  
測量装置の構造を簡素化することができ、しかも整準作  
業の時間を短縮することができる。

【0023】このような構成のレーザ測量装置は、前記  
第1および第2楔ガラスを透過したレーザビームを90  
° 偏向する反射部材と、前記反射部材を回転させること  
によりこの反射部材によって偏向されたレーザビームの  
出射方向を一定平面内で回転させる回転手段とをさらに  
備えるものであってもよい。

【0024】また、第2態様のレーザ測量装置は、前記  
レーザ光源から出射されたレーザビームを2以上のレー  
ザビームに分割するビーム分割手段と、前記ビーム分割

手段によって分割されたレーザビームのうちの1つを集光する集光レンズと、前記集光レンズの焦点面上に配置され、前記集光レンズによって集光されたレーザビームの入射位置を検知する光位置検出手段とをさらに備え、前記制御手段は前記第1および第2楔ガラスの回転を前記光位置検出手段に入射した前記レーザビームの入射位置の変化量に応じて制御するものであってもよい。

【0025】上記各態様のレーザ測量装置を用いる際には、前記ビーム分割手段は入射光の一部を透過するとともに残りを反射するビームスプリッタであってよいし、前記光位置検出手段は2次元ポジション・センシティブ・ディテクタ (PSD) であってよい。

【0026】さらに、上記各態様のレーザ測量装置は、前記ビーム分割手段によって分割されたレーザビームの他の1つを90°偏向する反射部材と、前記反射部材を回転させることによりこの反射部材によって偏向されたレーザビームの出射方向を一定平面内で回転させる回転手段とをさらに備えるものであってもよい。このとき、前記反射部材はペンタプリズムであってよい。また、このとき、前記レベル検知器によって検出される傾斜角は前記ビーム分割手段によって分割されて前記反射部材に入射するレーザビームのビーム軸の鉛直に対する傾きに対応していてもよい。

【0027】

【発明の実施の形態】以下、図面に基づいて、本発明の実施形態を説明する。

<第1実施形態>図1は、本発明の第1実施形態によるレーザ測量装置を構成する投光装置の構成を示す断面図である。この図1は、水平方向へのレーザ光走査を行うためにレーザ測量装置を鉛直方向に立てたときの投光装置の状態を示している。

【0028】投光装置11は、レーザ測量装置のハウジング (図示せず) 内に固定された鏡筒14と、ベアリング19を介して鏡筒14に回転自在かつ同軸に保持された回転投光部15とから構成されている。鏡筒14には、その機械軸1、(回転投光部15の回転軸と一致) に沿ったレーザビーム光路14bと、このレーザビーム光路14bに直交するレーザビーム光路14aとが、形成されている。また、回転投光部15には、レーザビーム光路14bに連通するとともにその回転軸と同軸に形成された中空のレーザビーム光路15a、およびこのレーザビーム光路15aに連通するとともに端面方向および側方に開口を有するペンタプリズム収容部15bが、形成されている。

【0029】(レーザ出射光学系) 鏡筒14内のレーザビーム光路14aおよび14bの交点には、ビーム分割手段としてのビームスプリッタ24が固定されている。また、このレーザ光光路14aの一方の端部には、レーザダイオード21が固定されている。また、このレーザダイオード21とビームスプリッタ24との間には、レ

ーザダイオード21側から、コリメータレンズ22、アナモプリズム23、およびビーム軸調整部33が固定されている。また、回転投光部15のペンタプリズム収容部15bには、ペンタプリズム27および楔形プリズム30が固定されている。

【0030】レーザ光源としてのレーザダイオード21は、レーザビームL<sub>1</sub>を出射する。コリメータレンズ22は、レーザダイオード21から出射されたレーザビームL<sub>1</sub>を平行光にするレンズである。また、アナモプリズム23は、コリメータレンズ22を透過したレーザビームL<sub>1</sub>の断面形状を真円形に修正するための光学素子である。

【0031】アナモプリズム23を透過したレーザビームL<sub>1</sub>は、光軸調整部33を透過して、ビームスプリッタ24に入射する (光軸調整部33については、後に詳述する)。ビームスプリッタ24内には、レーザビームL<sub>1</sub>のビーム軸に対してペンタプリズム27側に45°傾いた、部分透過膜24aが形成されている。この部分透過膜24aは、70~80%の反射率を有するため、レーザビームL<sub>1</sub>の20~30%を透過させるとともに残りのレーザビームを反射する特性を有している。従って、アナモプリズム23を透過したレーザビームL<sub>1</sub>の70~80%がペンタプリズム27側へ反射される。

【0032】このビームスプリッタ24を反射したレーザビームL<sub>1</sub>は、レーザ光光路14b内に固定された前群レンズ25および後群レンズ26に入射する。これら前群レンズ25および後群レンズ26は、入射されたレーザビームL<sub>1</sub>のビーム径を拡大するビームエキスパンダを構成する。

【0033】後群レンズ26を透過したレーザビームL<sub>1</sub>が入射するペンタプリズム27は、回転投光部15のペンタプリズム収容部15b内に、この回転投光部15と一体に回転するように固定されている。このペンタプリズム27は、レーザビームL<sub>1</sub>が入射する光入射面27cと、この光入射面27cに対して22.5°傾いているとともにこの光入射面27cから入射したレーザ光が反射する第1反射面27aと、この第1反射面27aに対して45°傾いているとともにこの第1反射面27aで反射されたレーザビームを再度反射する第2反射面27bと、光入射面27cに対して直角をなしているとともに第2反射面27bで反射されたレーザビームL<sub>1</sub>を出射する光出射面27dとを有している。なお、第2反射面27bには、図示せぬ増反射膜がアルミニウム蒸着によって形成されているので、この第2反射面27bにおいてレーザビームは100%内面反射する。一方、第1反射面27aには、反射率が70~80%の部分透過膜が形成されている。従って、20~30%のレーザビームL<sub>1</sub>がこの第1反射面27aを透過し、楔形プリズム30を通して投光装置12の上端から出射される。

【0034】ペンタプリズム27の光出射面27dから

出射されたレーザビーム $L_1$ は、ペンタプリズム収容部 15b の側方に開口した投光用窓 15c、および図示せぬハウジングの窓を透過して出射される。このようにして出射されたレーザビーム $L_1$ は、回転投光部 15 ごとペンタプリズム 27 がレーザビーム $L_1$ に直交する面内で回転することにより、壁面などに垂直または水平方向の基準線を投射する。

【0035】(回転機構) 次に、回転投光部 15 を鏡筒 14 に対して回転させるための機構(回転手段)を説明する。ベアリング 19 を介して鏡筒 14 に対して回転自在に接続された回転投光部 15 の外周面には、ギア 35 が固定されている。一方、鏡筒 14 の上端面には、外方に向けて突出させたブラケット 36 が設けられている。このブラケット 36 には、投光部回転用モータ 37 が固定されており、この投光部回転用モータ 37 の回転軸に取り付けられたピニオン 38 が回転投光部 15 のギア 35 に噛み合っている。この投光部回転用モータ 37 を回転させることにより、投光用窓 15c から出射されるレーザ光 $L_1$ の出射方向が回転投光部 15 の回転軸を中心に回転するので、この回転軸に直交する基準平面が形成される。

【0036】(整準機構) 前述したように、レーザビーム $L_1$ によって壁面などに垂直または水平方向の基準線を投射するためには、レーザビーム $L_1$ の出射方向が正確に調整されている必要がある。例えば、図 1 の状態においては、水平方向の基準線を投射するレーザビーム $L_1$ が正確に水平に投射されなければならない。以下、このようなレーザビーム $L_1$ の出射方向を調整するための整準機構について説明する。

【0037】図 2 は、図 1 のレーザ測量装置 10 における整準機構を説明するための、鏡筒 14 に固定された各部材の一部を示す図である。また、図 3 は、ビーム軸調整部 33 をビームスプリッタ 24 側から見た正面図であり、図 4 は、図 3 の A-A 線に沿った断面図である。ビーム軸調整部 33 には、透明部材としての 2 枚の円形の略平行ガラス 41、42 が互いに略平行となるように設置されており、これら略平行ガラス 41、42 の周縁部分は、環状のガラス押さえ枠 45、46 にはめ込まれている。ガラス押さえ枠 45 の、ガラス押さえ枠 46 に対向する開口縁には、略平行ガラス 41 を保持するための受け座 45d が形成されている。同様に、ガラス押さえ枠 46 のガラス押さえ枠 45 に対向する開口縁には、略平行ガラス 42 を保持するための受け座 46d が形成されている。

【0038】カバー 43 (弾性部材) は、弾性体からなる蛇腹状の円筒形状を有しており、その両開口縁は、ガラス押さえ枠 45、46 の受け座 45d、46d にそれぞれ接着されることにより、封止されている。そして、カバー 43 の内部にはシリコンオイルなどの液体が充填されることにより、液層 44 が形成されている。

【0039】ガラス押さえ枠 45、46 の外周面上には、矩形板状のピン取付部 45a、46a が、各ガラス押さえ枠 45、46 と一体に形成されている。ピン 47 は、その両端部が他の部分よりも細く形成されており、ピン取付部 45a、46a を貫通するように取り付けられている。このため、各ピン取付部 45a、46a が形成された部分における各ガラス押さえ枠 45、46 間の距離は、ほぼ一定に保たれている。但し、各ピン取付部 45a、46a は、ピン 47 に対してこのピン 47 の軸方向に若干の範囲で移動可能となっている。

【0040】また、ガラス押さえ枠 45 の外周面上には、矩形板状の 2 つのリードネジ保持部 45b、45c がこのガラス押さえ枠 45 と一体に形成されている。これらリードネジ保持部 45b、45c およびピン取付部 45a は、ガラス押さえ枠 45 の外周面の 3 等分位置から外方に突出するように、形成されている。そして、ガラス押さえ枠 46 のリードネジ保持部 45b に重なる外周面上には、リードネジ保持部 46b が形成されている。リードネジ保持部 46b には、ネジ孔 46e が形成されており、このネジ孔 46e には、リードネジ 48 がねじ込まれている。

【0041】リードネジ 48 は、他の部分よりも細く形成され、かつ、雄ねじが切られていない端部 48a を有しており、この端部 48a がリードネジ保持部 45b に回転自在に挿通されている。リードネジ保持部 45b を貫通した端部 48a には、ストッパリング 55 が嵌合されているため、リードネジ 48 は、リードネジ保持部 45b から落脱しないように保持されている。そして、リードネジ 48 は、その先端に固定されたリードネジギア 53、このリードネジギア 53 に噛合するモータギア 52 を介して、リードネジ保持部 45b に固定されたモータ 51 によって回転される。このモータ 51 は、制御部 35 によって駆動制御されている。このモータ 51 によるリードネジ 48 の回転に伴い、リードネジ保持部 46b がリードネジ 48 の軸方向(図 4 の B 方向)に沿って移動される。このため、リードネジ保持部 45b、46b が形成された部分における各略平行ガラス 42、43 間の距離は変化される。また、リードネジ保持部 45c、46c についても、リードネジ保持部 45b、46b と同様の機構が設けられている。このため、リードネジ保持部 45c が形成された部分における各略平行ガラス 42、43 間の距離も、制御部 35 によって変化される。

【0042】図 5 に、モータ 51 が回転されたときの光軸調整部 33 の様子を示す。上述したように、モータ 51 が回転されることによりリードネジ 48 が回転し、これに伴い、リードネジ保持部 46b がこのリードネジ 48 の軸に沿って移動する。このため、図 5 に示すように、この部分における各略平行ガラス 41、42 間の距離は小さくなる。一方、各ピン取付部 45a、46a が

形成された部分における各略平行ガラス41, 42間の距離は、ピン47によって一定に保たれている。従って、各略平行ガラス41, 42は平行より若干の角度を持って対向する状態となる。このとき、各略平行ガラス41, 42のなす角（すなわち液層44の頂角）を $\theta^\circ$ とし、液層44の屈折率を $n$ （但し、 $n \approx 1.5$ ）とする。そして、略平行ガラス42に入射し、液層44を透過して略平行ガラス41から出射されるレーザビーム $L_1$ のビーム軸の偏角を $\theta'^\circ$ とすると、次式の関係が成り立つ。

$$\theta' = (n-1)\theta \quad \dots (1)$$

すなわち、液層44の頂角 $\theta$ の大きさを制御することにより、このビーム軸調整部33を透過するレーザビーム $L_1$ のビーム軸の向きを変化させることができる。

【0043】また、図1および図2に示すように、鏡筒14のレーザ光光路14aのレーザダイオード21に対向する端面には、光位置検出手段としての2次元ポジション・センシティブ・ディテクタ（以下、「PSD」という）29が、その受光面をビームスプリッタ24側に向けて固定されている。また、レーザ光光路14a内の2次元PSD29とビームスプリッタ24との間には、集光レンズ28が固定されている。この集光レンズ28と2次元PSD29との間の距離は、集光レンズ28の焦点距離 $f_1$ に等しい。よって、レーザダイオード21から出射され、ビームスプリッタ24に入射したレーザビーム $L_1$ のうち、部分透過膜24aを透過した20～30%のレーザビーム $L_1$ は、集光レンズ28を透過して2次元PSD29上に集光される。2次元PSD29は、光の入射位置を検出する機器である。2次元PSDへのレーザビーム $L_1$ の入射位置は、この2次元PSD29の各出力端子から出力される電流比に基づいて算出される。なお、この2次元PSDの各出力端子は制御部35に接続されている。

【0044】また、鏡筒14のレーザ光光路14bの下端部には、x方向（紙面内での回転方向）の水平からの傾きを検出するチルトセンサ31（レベル検知器）が固定されている。そして、チルトセンサ31の側方には、y方向（鉛直方向に沿って紙面に直交する面内での回転方向）の水平からの傾きを検出するチルトセンサ32が固定されている。チルトセンサ31, 32は電解液が満たされた気泡管内の気泡の位置変化を抵抗値変化としてとらえて電気信号に変換することにより水平からの傾きを検出するものである。すなわち、チルトセンサ31, 32の上面には、それぞれ、2個の電極（図示せず）が傾斜角の検出方向に対象な位置関係で設けられており、その下面全域には共通の電極が設けられている。従って、各チルトセンサ31, 32内で気泡の位置が変化するとこれら上面上の各電極と共通電極との間の抵抗値の比が変化する。各チルトセンサ31, 32はこれら各電極を介して制御部35に接続されており、各電

極に生じる抵抗値同士の比の変化に基づいて、鏡筒14の傾きの変化量が算出される。

【0045】図2の状態では、図示せぬ測定装置が用いられることにより、レーザビーム $L_1$ が正確に水平に出射され、レーザビーム $L_1$ が鉛直方向1<sub>1</sub>に出射されるように、鏡筒14の向きが調整されているものとする。なお、このとき、レーザビーム $L_1$ のビーム軸と鏡筒14の機械軸1<sub>1</sub>とは、完全に一致しているものとする。このときのチルトセンサ31, 32の測定値、およびレーザビーム $L_1$ の2次元PSD29への入射位置は、初期値として制御部へ記憶される。このときの、レーザビーム $L_1$ の2次元PSD29への入射位置のPSD中心座標 $a_1$ からのx方向における距離を $a_1$ とする。ここで、鏡筒機械軸1<sub>1</sub>と鉛直方向1<sub>1</sub>とは完全に一致した状態であるので、各チルトセンサ31, 32による測定値は、鏡筒14の機械軸1<sub>1</sub>が鉛直であるときの値を示すが、鏡筒機械軸1<sub>1</sub>とレーザビーム $L_1$ のビーム軸との位置関係によっては、この測定値が必ずしも鉛直時の値を示す必要はない。

【0046】図6は、図2の状態からペンタプリズム27の光出射面27dから出射されたレーザビーム $L_1$ のビーム軸が水平からx方向に $+\Delta\omega^\circ$ 傾いたとき、すなわちレーザビーム $L_1$ のビーム軸が鉛直から $+\Delta\omega^\circ$ 傾いた状態を示している（図6のx方向において、時計方向の向きを+としている）。このとき、鏡筒14の機械軸1<sub>1</sub>も同様に図2の状態から鉛直方向1<sub>1</sub>に対して $+\Delta\omega^\circ$ 傾いた状態となっているため、チルトセンサ31の測定値も初期値から $+\Delta\omega^\circ$ の傾き相当変化する。

【0047】すると、制御部35によりチルトセンサ31の測定値が読み込まれる。制御部35は、チルトセンサ31の測定値に基づいてレーザビーム $L_1$ のビーム軸の傾斜量 $+\Delta\omega^\circ$ を算出する。それに応じて、ビーム軸調整部33の各リードネジ保持部45b, 45cのモータ51, 51が回転され、モータギア52, 52およびリードネジギア53, 53を介して連通されたリードネジ48, 48がそれぞれ回転されるため、リードネジ保持部46b, 46cがリードネジ48, 48の軸方向に移動される。これにより、液層44が形成する頂角 $\theta$ の大きさが変化されるため、レーザビーム $L_1$ のビーム軸の出射方向が調整される。図7に、液層44の頂角 $\theta$ の大きさが変化されることによって、レーザビーム $L_1$ のビーム軸が鉛直方向1<sub>1</sub>になるように調整された様子を示す。レーザビーム $L_1$ が鉛直方向1<sub>1</sub>に出射されるよう調整するためには、ビーム軸調整部33から出射されるレーザビーム $L_1$ のビーム軸を、コリメータレンズ22の光軸に対して $+\Delta\omega^\circ$ だけ傾斜させる必要がある。レーザビーム $L_1$ のビーム軸が、コリメータレンズ22の光軸に対して $+\Delta\omega^\circ$ 傾斜されたとき、x方向におけるレーザビーム $L_1$ の2次元PSD29への入射位置の初期値 $a_1$ からのズレ量 $b$ は、 $b = f_1 \tan(+\Delta\omega^\circ)$

となる。従って、制御部 33 は、2 次元 PSD 29 から出力されたレーザビーム  $L_1$  の入射位置を常にモニタしながら各モータ 51、51 を駆動制御し、2 次元 PSD 29 に入射するレーザビーム  $L_1$  の入射位置の中心座標  $a_1$  からの x 方向のズレが  $a_1 + b = a_1 + f_1 \tan(+\Delta\omega)$  となるように、ビーム軸調整部 33 の液層 44 の頂角  $\theta$  を変化させるのである。このときの液層 44 の頂角  $\theta$  は、(1) 式より、

$$\theta = \theta' / (n-1) \\ = \Delta\omega / (n-1) \quad (\text{但し、} n \text{ は液層 44 の屈折率})$$

となるように変化される。これにより、レーザビーム  $L_1$  のビーム軸は、図 6 の状態から  $-\Delta\omega$  だけ傾斜されて鉛直方向  $1_1$  と一致する。従って、回転投光部 15 から出射されるレーザビーム  $L_1$  のビーム軸が水平になるよう調整される。

【0048】なお、ここでは、チルトセンサ 31 によって検出される、レーザビーム  $L_1$  のビーム軸の傾きの x 方向の調整のみについて説明したが、チルトセンサ 32 によって検出される y 方向のビーム軸の調整も、同様に行われる。

【0049】すなわち、本実施形態のレーザ測量装置では、レーザビーム  $L_1$  によって形成される基準平面の水平からの傾きに依じてビーム軸調整部 33 の液層 44 の頂角  $\theta$  の大きさを調整することによりレーザビーム  $L_1$  の出射方向を調整している。また、ビーム軸調整部 33 を駆動させたときの各ビーム軸の向きの変化を、コリメータレンズ 22 の光軸上に設置した 2 次元 PSD 29 へのレーザビーム  $L_1$  の入射位置によって監視している。このため、ビーム軸調整部 33 によるビーム軸  $L_1$  の向きの僅かな変化量を高精度に調整することができる。

【0050】このように、本実施形態のレーザ測量装置は、液層 44 を封止した 2 枚の略平行ガラス 41、42 の相対角度を変化させることにより整準を行っているの、従来のように鏡筒全体を傾けるための複雑な構造を必要としない。このため、レーザ測量装置の構造を簡単にすることができる。また、本実施形態のレーザ測量装置は、整準の際に投光装置 11 をハウジングに対して傾ける必要がないため、整準作業の途中でチルトセンサ 31、32 の測定値が変化することもない。よって、従来のように、チルトセンサの測定値を安定させるための時間を必要としないので、整準作業を短時間に行うことができる。

【0051】<第 2 実施形態> 図 8 に本発明の第 2 実施形態におけるレーザ測量装置の整準機構およびレーザ射出光学系の一部を示す。本第 2 実施形態は、鉛直方向にレーザ走査するために、鏡筒 14 を図 1 の状態に対して  $90^\circ$  傾けて用いる場合に適用される。

【0052】x 方向（紙面内での回転方向）のチルトセンサ 61 は、レーザビーム  $L_1$  のビーム軸方向が水平方向  $1_1$  となるように、図 1 の状態に対して x 方向に 9

$0^\circ$  傾けられた状態で固定されている。そして、第 1 実施形態と同様、x 方向のチルトセンサ 61 は、ビーム軸調整部 33 や 2 次元 PSD 29 とともに制御部 53 に接続されている。

【0053】以下、本実施形態のレーザ測量装置の整準機構の動作を説明する。まず、制御部 53 は、図 8 のように、レーザ光  $L_1$  のビーム軸が水平方向  $1_1$  となるように調整されているときの、チルトセンサ 61 の測定値と 2 次元 PSD 29 へのレーザビーム  $L_1$  の入射位置を記憶する。なお、このとき、レーザビーム  $L_1$  のビーム軸と鏡筒 14 の機械軸  $1_1$  とは完全に一致しているものとする。このとき、レーザビーム  $L_1$  の 2 次元 PSD 29 への入射位置の PSD 中心  $a_1$  からの x 方向における距離を  $a_1$  とする。そして、図 9 に示すように、レーザビーム  $L_1$  のビーム軸が水平方向  $1_1$  から x 方向に  $+\Delta\omega$  ずれた場合には、制御部 53 は、2 次元 PSD 29 へのレーザビーム  $L_1$  の x 方向の入射位置の PSD 中心  $a_1$  からの距離が  $a_1 + f_1 \tan(+\Delta\omega)$  となるように、ビーム軸調整部 33 の略平行ガラス 41 に対する略平行ガラス 42 の角度を変化させて、レーザビーム  $L_1$  のビーム軸の方向を調整する。このようにして、レーザビーム  $L_1$  のビーム軸を図 9 の状態より  $-\Delta\omega$  回転させて、水平方向  $1_1$  を向かせるように調節することができる（図 10 参照）。

【0054】このように、本実施形態では、鉛直方向のレーザ走査を行うために、レーザ測量装置を水平方向に向けて使用する場合でも、第 1 実施形態と同様に液層 44 を封止した 2 枚の略平行ガラス 41、42 の相対角度を変化させることによりレーザビーム  $L_1$  のビーム軸の方向が調整されるビーム軸調整部 33 を用いて整準作業を行っている。これにより、レーザビーム  $L_1$  のビーム軸の向きを鏡筒機械軸  $1_1$  に対して傾斜させて、レーザビーム  $L_1$  のビーム軸が水平になるように調整することができる。

【0055】<第 3 実施形態> 図 11 は、本発明の第 3 実施形態のレーザ測量装置におけるビーム軸調整部 63 の構造を示す断面図である。本第 3 実施形態のレーザ測量装置は、2 枚の楔ガラスをコリメータレンズ 22 の光軸を中心としてそれぞれ回転させることによりレーザ光  $L_1$  のビーム軸の向きを調整することにより整準作業を行うことを特徴とし、その他の部分を第 1 および第 2 実施形態と同一とする。

【0056】鏡筒 14 のレーザ光光路 14a 内に固定されたビーム軸調整部 63 は、透明部材からなる箱形のケーシング 66 と、このケーシング 66 内に保持された 2 枚の楔ガラス 64、65 とから構成される。楔ガラス 64、65 は、平行より僅かに角度を持って相対した平面からなる光学素子であり、それらの入射面をレーザダイオード 21 側に向けるように並べて配置されている。これら各楔ガラス 64、65 は、コリメータレンズ 22 の



光軸に垂直な面内で回転自在な状態でケーシング 66 内に保持されている。また、各楔ガラスの 64、65 の回転軸は、コリメータレンズ 22 の光軸と一致するように、構成されている。これら各楔ガラス 64、65 の外周部分には、ギア 67、68 がそれぞれ嵌合されており、各ギア 67、68 はケーシング 66 内に固定されたモータ 69、70 によって回転される。これら各モータ 69、70 は制御部 35 に接続されており、この制御部 35 によって各楔ガラス 64、65 の回転制御がなされている。なお、本実施形態では、各ギア 67、68 および各モータ 69、70 とを併せて、「回転機構」として

【0057】このビーム軸調整部 63 にレーザ光  $L_1$  が入射されると、2 枚の楔ガラス 64、65 を透過することによりこのレーザ光  $L_1$  のビーム軸が屈曲される。そして、制御部 35 によって各楔ガラス 64、65 が回転されると、ビーム軸調整部 63 を透過するレーザビーム  $L_1$  のビーム軸の向きが変化される。このようにして、レーザビーム  $L_1$  のビーム軸の向きを調整することにより、レーザビーム  $L_1$  のビーム軸が鉛直方向  $1_1$  に出射されるよう調整することができる。

【0058】以下、図 2、6、7、および 11 を用いて、上記構成のビーム軸調整部 63 を用いた本実施形態のレーザ測量装置の整準方法を説明する。前述したように、鏡筒 14 の向きは、図示せぬ測定装置により、レーザビーム  $L_1$  が正確に水平に出射され、レーザビーム  $L_1$  が鉛直方向  $1_1$  に出射されるように、調整されている（このとき、レーザ光  $L_1$  のビーム軸と鏡筒 14 の機械軸  $1_1$  は完全に一致している）。このときのチルトセンサ 31、32 の測定値、およびレーザビーム  $L_1$  の 2 次元 PSD 29 への入射位置は、制御部 35 に記憶される。第 1 実施形態と同様に、このときのレーザビーム  $L_1$  の 2 次元 PSD 29 への入射位置の PSD 中心  $a_1$  からの距離を  $a_1$  とする。そして、図 6 に示すように、レーザビーム  $L_1$  のビーム軸が鉛直方向  $1_1$  に対して  $+\Delta\omega^\circ$  ずれた場合には、制御部 35 は、2 次元 PSD 29 へのレーザビーム  $L_1$  の x 方向の入射位置の PSD 中心  $a_1$  からの距離が  $a_1 + f_1 \tan(+\Delta\omega^\circ)$  となるように各モータ 69、70 の回転制御を行い、各楔ガラス 64、65 をコリメータレンズ 22 の光軸に直交する面内で回転させることにより、ビームスプリッタ 24 に入射されるレーザビーム  $L_1$  のビーム軸の向きを調整する。このようにして、レーザビーム  $L_1$  のビーム軸を図 6 の状態より  $-\Delta\omega^\circ$  回転させて、鉛直方向  $1_1$  を向かせるように調整することができる（図 7）。

【0059】なお、ここでは、水平方向のレーザ走査を行うために、図 1 のようにレーザ測量装置を鉛直に立てて用いた場合の整準機構について説明したが、鉛直方向へのレーザ走査を行う際にも、第 2 実施形態と同様にチルトセンサ 31 を図 1 の状態から  $90^\circ$  回転された状態

で固定することにより、同様の整準作業を行うことができる。

【0060】

【発明の効果】本発明によれば、複雑な整準機構を必要とせず、レーザ測量装置の構造を簡素化することができる。また、整準作業を短時間で行うことができるレーザ測量装置を提供することができる。

【図面の簡単な説明】

【図 1】 本発明の第 1 実施形態によるレーザ測量装置の構造を示す断面図

【図 2】 本発明の第 1 実施形態によるレーザ測量装置の整準機構を説明するための図

【図 3】 本発明の第 1 実施形態によるレーザ測量装置におけるビーム軸調整部 33 の正面図

【図 4】 図 3 の A-A 線に沿った断面図

【図 5】 モータ 51 を回転させたときのビーム軸調整部 33 の状態を示す断面図

【図 6】 図 2 の状態からレーザビーム  $L_1$  のビーム軸が  $+\Delta\omega^\circ$  傾いた様子を示す図

【図 7】 図 6 の状態から整準作業が行われた様子を示す図

【図 8】 本発明の第 2 実施形態によるレーザ測量装置の整準機構を説明するための図

【図 9】 図 8 の状態からレーザビーム  $L_1$  のビーム軸が  $+\Delta\omega^\circ$  傾いた様子を示す図

【図 10】 図 9 の状態から整準作業が行われた様子を示す図

【図 11】 本発明の第 3 実施形態のレーザ測量装置におけるビーム軸調整部 63 の構造を示す断面図

【図 12】 従来技術のレーザ測量装置の構造を示す断面図

【符号の説明】

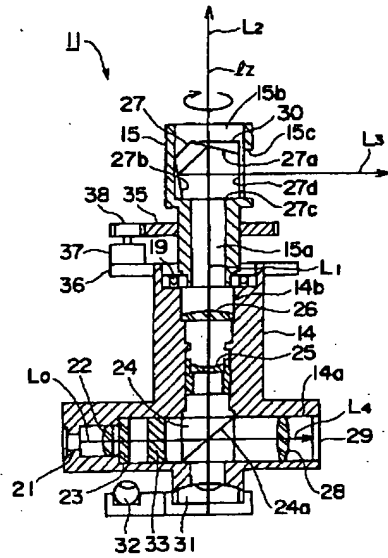
- 21 レーザダイオード
- 22 コリメータレンズ
- 24 ビームスプリッタ
- 27 ペンタプリズム
- 28 集光レンズ
- 29 2次元 PSD
- 31、32、61、62 チルトセンサ
- 33、63 ビーム軸調整部
- 35、53 制御部
- 41、42 略平行ガラス
- 43 カバー
- 44 液層
- 45、46 ガラス押さえ枠
- 45b、46b リードネジ保持部
- 47 ピン
- 48 リードネジ
- 51 モータ
- 52 モータギア

53 リードネジギア

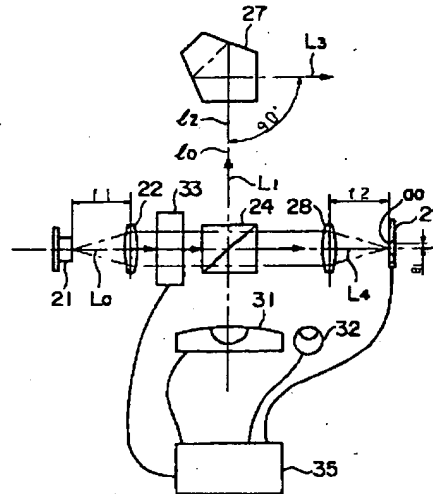
64, 65 楔ガラス

 $L_1, L_2, L_3, L_4$  レーザビーム $\theta$  頂角

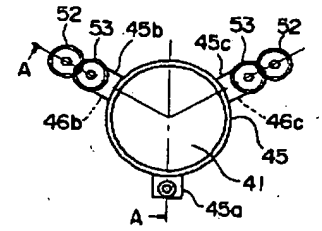
【図1】



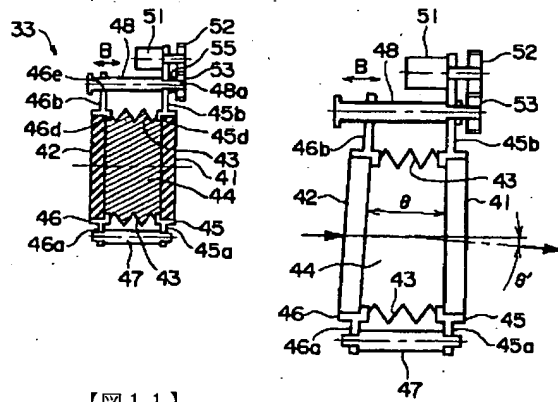
【図2】



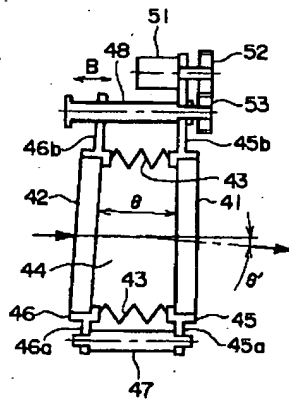
【図3】



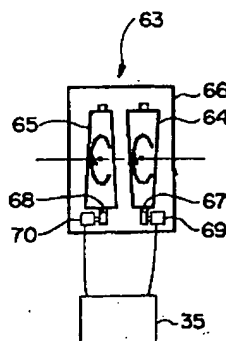
【図4】



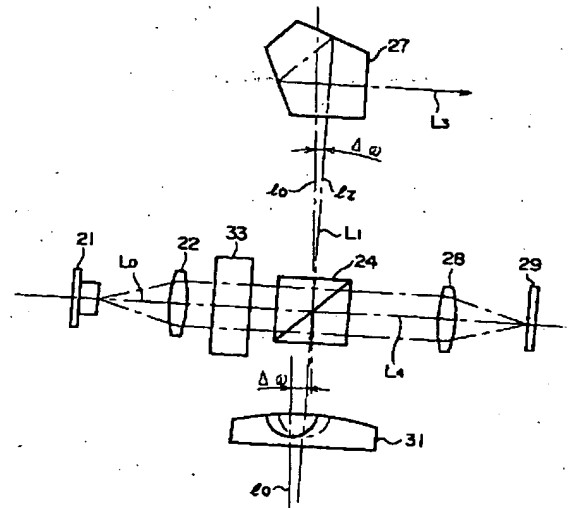
【図5】



【図11】

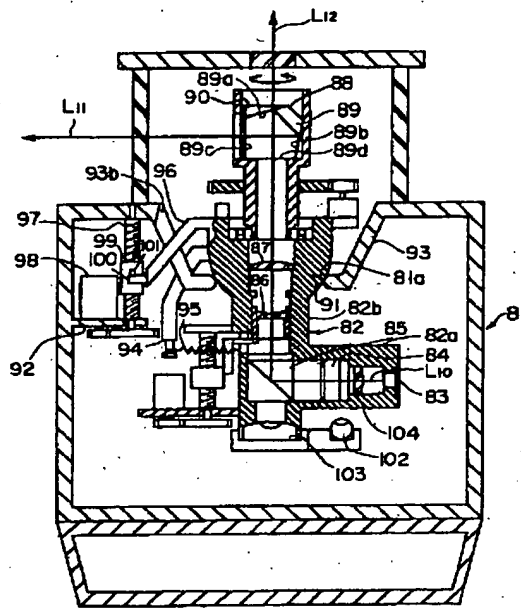


【図6】





【図12】



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(72)Inventor : ITO EIICHI

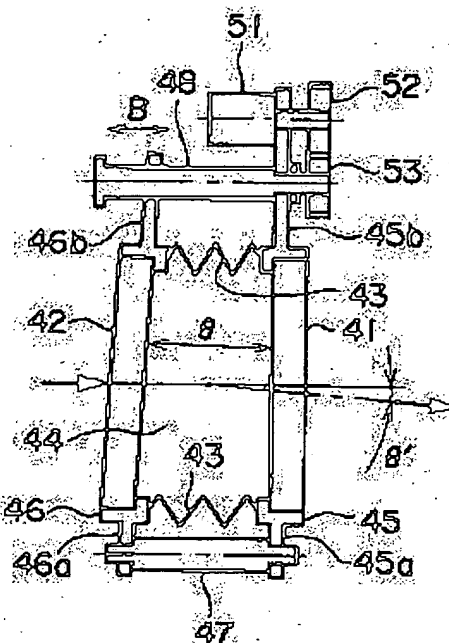
## (54) LASER MEASURING INSTRUMENT

## (57)Abstract:

PROBLEM TO BE SOLVED: To provide the laser measuring instrument which can simplify a structure for leveling and completes leveling operation in a short time.

SOLUTION: A bellows type cover 43 made of an elastic body is sealed with two nearly parallel glasses 41 and 42 and the cover 43 is filled with a liquid layer 44. A lead screw hold part 46b formed on a glass pressure frame 46 holding the nearly parallel glass 42 threadably engages a lead screw 48. A motor 51 is rotated to rotate the lead screw 48 and then the lead screw hold part 46b is moved forward and backward in a direction B.

Consequently, the vertical angle  $\theta$  of the liquid layer 44 varies and the direction of the beam axis of a laser beam transmitted through the two nearly parallel glasses 41 and 42 is refracted according to the vertical angle  $\theta$ .



## LEGAL STATUS

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[Date of extinction of right]

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## CLAIMS

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### [Claim(s)]

[Claim 1] Laser survey equipment characterized by providing the following Laser light source the [ which has been arranged on the optical path of the laser beam by which outgoing radiation was carried out from the aforementioned laser light source / abbreviation plate-like / the 1st and ] -- 2 transparent member the [ the above 1st and ] -- the tubed elastic member by which the double door peristome was closed by 2 transparent member the [ the solution layer formed by filling up with a liquid in the aforementioned elastic member, and / the above 1st and ] -- with the lens-barrel holding 2 transparent member The adjustment mechanism the above 1st held at this lens-barrel and whose adjustment in the range which includes parallel for the relative tilt angle of a member the 2nd transparence are enabled, Control means which adjust the size of the angle which controls the aforementioned adjustment mechanism according to the size of the aforementioned tilt angle detected in the level detector which detects the tilt angle to the level surface of the aforementioned lens-barrel, and the aforementioned level detector, and the aforementioned 1st area-pellucida material and the aforementioned 2nd area-pellucida material make

[Claim 2] The aforementioned elastic member is laser survey equipment according to claim 1 which has the bellows-like configuration.

[Claim 3] The liquid which forms the aforementioned solution layer is laser survey equipment according to claim 1 which is a silicone oil. [Claim 4] the [ the above 1st and ] -- the laser survey equipment according to claim 1 to 3 further equipped with the reflective member which deflects 90 degrees of laser beams which penetrated 2 transparent member, and a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member by rotating the aforementioned reflective member within a fixed flat surface

[Claim 5] A beam division means to divide into two or more laser beams the laser beam by which outgoing radiation was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ aforementioned ] -- the [ 1 transparent member and / aforementioned ] -- the laser survey equipment according to claim 1 to 3 which computes the size of the angle which 2 transparent member makes based on the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means

[Claim 6] Laser survey equipment characterized by providing the following Laser light source The 1st wedge glass which penetrates the laser beam by which outgoing radiation was carried out from the aforementioned laser light source while being held in the lens-barrel possible [ rotation ] centering on the beam shaft of this laser beam The 2nd wedge glass which penetrates the laser beam which penetrated the aforementioned 1st wedge glass while being held in the lens-barrel possible [ rotation ] centering on the beam shaft of the aforementioned laser beam the [ the above 1st held at the aforementioned lens-barrel, and ] -- the size of the aforementioned tilt angle detected in the rolling mechanism which rotates 2 wedge glass, the

level detector which detects the tilt angle to the level surface of the aforementioned lens-barrel, and the aforementioned level detector -- responding -- the aforementioned rolling mechanism -- controlling -- the [ the above 1st and ] -- the control means which adjust the direction of outgoing radiation of the laser beam which penetrates 2 wedge glass

[Claim 7] the [ the above 1st and ] -- the laser survey equipment according to claim 6 further equipped with the reflective member which deflects 90 degrees of laser beams which penetrated 2 wedge glass, and a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member by rotating the aforementioned reflective member within a fixed flat surface

[Claim 8] A beam division means to divide into two or more laser beams the laser beam by which outgoing radiation was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ the above 1st and ] -- the laser survey equipment according to claim 6 which controls rotation of 2 wedge glass according to the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means

[Claim 9] The aforementioned beam division means is laser survey equipment according to claim 5 or 8 which is the beam splitter which reflects the remainder while penetrating a part of incident light.

[Claim 10] The aforementioned optical position detection means is laser survey equipment according to claim 5 or 8 which is a two-dimensional position sensitive detector (PSD).

[Claim 11] Laser survey equipment according to claim 5 or 8 further equipped with the reflective member which deflects other one [ 90-degree ] of the laser beams divided by the aforementioned beam division means, and a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member by rotating the aforementioned reflective member within a fixed flat surface.

[Claim 12] The aforementioned reflective member is laser survey equipment given in either of the claims 4, 7, and 11 which are pentaprisms.

[Claim 13] The tilt angle detected in the aforementioned level detector is laser survey equipment given in either of the claims 4, 7, 11, and 12 corresponding to the inclination to the vertical of the beam shaft of the laser beam which it is divided by the aforementioned beam division means, and carries out incidence to the aforementioned reflective member.

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[Translation done.]



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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates the datum line by the laser beam to horizontal or the laser survey equipment projected perpendicularly to a predetermined field.

[0002]

[Description of the Prior Art] Conventionally, in fields, such as engineering works and construction, the laser survey equipment (the so-called laser planar) for performing marking of a horizontal line or a vertical line is used. This laser equipment rotates the floodlighting section which carries out outgoing radiation of the laser beam, scans this laser beam to a hoop direction, and projects the datum line perpendicular to planes of incidence-ed, such as a wall surface, or horizontal by tracing of a laser beam.

[0003] Drawing 12 is the cross section showing the composition of conventional laser survey equipment. This drawing 12 shows the state where laser survey equipment was stood in the perpendicular direction, in order to perform the laser beam scan to a horizontal direction. The lens-barrel 82 dedicated in housing 81 consists of laser beam optical-path 82a of the hollow which branched at the right angle from laser beam optical-path 82b of the hollow which penetrates the whole along with the medial axis of laser survey equipment, and this laser beam optical-path 82b. In laser beam optical-path 82a, a laser diode 83, the collimator lens unit 104, and the ANAMO prism 84 are being fixed from the end-face side. And the rectangular prism 85 is being fixed to the intersection of the laser beam optical paths 82a and 82b.

[0004] In laser beam optical-path 82b, the pre-group lens 86 and the back group lens 87 are being fixed toward the upper part in drawing 12 from the rectangular prism 85. The approximate circle tubed rotation floodlighting section 88 to which the pentaprism 89 was dedicated is being fixed to the upper-limit section of a lens-barrel 82 free [ rotation ] in the field which intersects perpendicularly with laser beam optical-path 82b. Opening is formed in the upper-limit side and the side of this rotation floodlighting section 88, respectively.

[0005] In the laser survey equipment of such composition, if outgoing radiation of the laser beam L10 is carried out from the laser diode 83 fixed to the laser beam optical-path 82a end face, in a rectangular prism 85, 90 degrees of the laser beam L10 will be crooked in the rotation floodlighting section 88 side, it will penetrate the pre-group lens 86 and the back group lens 87, and they will carry out incidence to a pentaprism 89. The laser beam L10 which carried out incidence to the pentaprism 89 is gradually reflected by 2nd reflector 89b which inclined 45 degrees to 1st reflector 89a and this 1st reflector. And outgoing radiation of the laser beam L11 which reflector [ 1st ] 89a Reached and was reflected by 2nd reflector 89b is carried out from optical outgoing radiation side 89c which is making the right angle to 89d of optical plane of incidence.

[0006] Moreover, the partial reflection film is formed in 1st reflector 89a. Therefore, some laser beams L12 penetrate this 1st reflector 89a, penetrate the wedge prism 90 fixed on this 1st reflector 89a, and outgoing radiation is carried out from opening of a rotation floodlighting section 88 upper-limit side.

[0007] And a laser beam L11 rotates focusing on the axis of rotation of the rotation floodlighting section 88 by rotating in the field where laser beam optical-path 82b and the rotation floodlighting section 88 cross at right angles. Therefore, the base plane which intersects perpendicularly with this

axis of rotation is formed of a laser beam L11. Moreover, the laser beam L12 by which outgoing radiation is carried out from the upper limit of the rotation floodlighting section 88 forms the criteria spot for a survey control point etc. being shown in a ceiling etc.

[0008] Thus, in order to form a base plane in a wall surface etc., outgoing radiation of the laser beam L11 by which outgoing radiation was carried out from laser survey equipment needs to be carried out horizontally correctly. Similarly, outgoing radiation also of the laser beam L12 which forms a criteria spot needs to be correctly carried out to a ceiling etc. perpendicularly. Therefore, at the time of use of laser survey equipment, it is necessary to do leveling-up work so that outgoing radiation of the laser beam L11 may be carried out horizontally correctly.

[0009] Hereafter, the leveling-up mechanism for outgoing radiation of the laser beam L11 being carried out horizontally correctly is explained. sliding which the bulge section 91 which has a semi-sphere side configuration is formed in the upper-limit side of a lens-barrel 82, and was formed in housing 81 -- a hole -- it is held in the state where it contacted in 81a since the maintenance to the housing 81 of a lens-barrel 82 is made by only contact of this portion -- sliding -- a hole -- the lens-barrel 82 whole can be made to tilt in all the directions by rotating the semi-sphere side portion of the bulge section 91 within 81a

[0010] Moreover, in housing 81, the screw 97 rotated by the motor 98 for level adjustment is formed. The nut 99 is screwed in this screw 97. This nut 99 moves up and down with rotation of a screw 97. The operation pin 101 is projected and formed in the superficies of a nut 99. The drive arm 96 formed in the bulge section 91 and the pin 100 open for free passage touch the operation pin 101, and, thereby, rotation of the direction of X of the bulge section 91 (hand of cut within space) is regulated.

[0011] Furthermore, under the rectangular prism 85, the tilt sensor 103 of the direction of X which detects the inclination of the direction of X of a lens-barrel 82 is being fixed in the lens-barrel 82. According to the inclination detected by this tilt sensor 103, the roll control of the motor 98 for level adjustment is performed, and a screw 97 rotates by this. Then, a nut 99 moves up and down with rotation of this screw 97, and the bulge section 91 linked through the operation pin 101 and the pin 100 rotates in the direction of X. In addition, the tilt sensor 102 of the direction of Y which detects the inclination of the direction (hand of cut in the field which intersects perpendicularly with space along the perpendicular-among drawing direction) of Y is being fixed to the side of the tilt sensor of the direction of X. Moreover, although not shown in the drawing, in housing 81, the mechanism for regulating rotation of the direction of Y of the bulge section 91 as well as the direction of X is established according to the size of the inclination detected by the tilt sensor 102. Thus, it is adjusted so that a lens-barrel 82 may always turn to the perpendicular direction, namely, so that outgoing radiation of the laser beam L11 may always be carried out horizontally. Therefore, a laser beam L11 can form always exact datum level.

[0012]

[Problem(s) to be Solved by the Invention] However, with the structure of conventional laser survey equipment which was mentioned above, the leveling-up work for carrying out outgoing radiation of the laser beam L11 horizontally is done by leaning a lens-barrel 82 using the motor 98 for level adjustment, a screw 97, and nut 99 grade. For this reason, there was a problem that the structure of laser survey equipment will become complicated.

[0013] Moreover, if an inclination changes, the tilt sensor 102,103 will require fixed time until the measured value is stabilized possible [ measurement ]. For this reason, you have to wait to stabilize the measured value of the tilt sensor 102,103, whenever the inclination of a lens-barrel 82 changes, when adjustment by leaning a lens-barrel 82 like before is performed. For this reason, the long time was required in order to do leveling-up work.

[0014] Then, structure for a leveling up can be simplified and let it be the technical problem of this invention to offer the laser survey equipment which can moreover do leveling-up work in a short time.

[0015]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the 1st mode of the laser survey equipment of this invention the [ which has been arranged on the optical path of the laser beam by which outgoing radiation was carried out from the laser light source and

the aforementioned laser light source / abbreviation plate-like / the 1st and ] -- with 2 transparent member the [ the above 1st and ] -- with the tubed elastic member by which the double door peristome was closed by 2 transparent member the [ the solution layer formed by filling up with a liquid in the aforementioned elastic member, and / the above 1st and ] -- with the lens-barrel holding 2 transparent member The adjustment mechanism the above 1st-held at this lens-barrel and whose adjustment in the range which includes parallel for the relative tilt angle of a member the 2nd transparence are enabled, The aforementioned adjustment mechanism is controlled according to the size of the aforementioned tilt angle detected in the level detector which detects the tilt angle to the level surface of the aforementioned lens-barrel, and the aforementioned level detector, and it has the control means which adjust the size of the angle which the aforementioned 1st area-pellucida material and the aforementioned 2nd area-pellucida material make.

[0016] That is, the unit which closed the elastic member by the 1st and 2nd transparent members, and filled up the liquid with the laser survey equipment of the 1st mode into it is arranged on the optical path of a laser beam. And the sense of the beam shaft which penetrates each [ these ] transparent member is changed by changing the angle which each transparent member makes according to the size of the inclination of the level shell of the lens-barrel detected in the level detector. Therefore, since it is not necessary to establish like before the complicated leveling-up mechanism in which a lens-barrel is leaned, the structure of laser survey equipment can be simplified. Moreover, with the laser survey equipment of the 1st mode, since it is accepted by changing the size of the angle which each transparent member makes and the sense of a beam shaft is adjusted, it is not necessary to change the sense of the whole lens-barrel. Therefore, since the measured value of a level detector is always fixed, in case it does leveling-up work like before through leveling-up work, it does not require time until the measured value of a level detector is stabilized. Therefore, the time of leveling-up work can be shortened.

[0017] In case the laser survey equipment of such composition is used, it is good also as what has a bellows-like configuration for the aforementioned elastic member, and is good also considering the liquid which forms the aforementioned solution layer as a silicone oil.

[0018] moreover, the laser survey equipment of the above-mentioned composition -- the [ the above 1st and ] -- you may have further a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects 90 degrees of laser beams which penetrated 2 transparent member, and the aforementioned reflective member

[0019] Furthermore, a beam division means to divide into two or more laser beams the laser beam to which outgoing radiation of the laser survey equipment of the above-mentioned composition was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ aforementioned ] -- the [ 1 transparent member and / aforementioned ] -- based on the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means, you may compute the size of the angle which 2 transparent member makes

[0020] If the laser survey equipment of such composition is adopted, the size of the angle which each transparent member makes can be made to be able to respond to the variation of the incidence position to the optical position sensing element of the beam divided by the beam division means, and can be detected. Therefore, the sense of a beam shaft can be adjusted more precisely.

[0021] Moreover, the 2nd mode of the laser survey equipment of this invention A laser light source and the 1st wedge glass which penetrates the laser beam by which outgoing radiation was carried out from the aforementioned laser light source while being held in a lens-barrel possible [ rotation ] centering on the beam shaft of this laser beam, The 2nd wedge glass which penetrates the laser beam which penetrated the aforementioned 1st wedge glass while being held in a lens-barrel possible [ rotation ] centering on the beam shaft of the aforementioned laser beam, the [ the above 1st held in the aforementioned lens-barrel, and ] -- with the rolling mechanism which rotates 2 wedge glass the size of the aforementioned tilt angle detected in the level detector which detects the tilt angle to the

level surface of the aforementioned lens-barrel, and the aforementioned level detector -- responding -- the aforementioned rolling mechanism -- controlling -- the [ the above 1st and ] -- it has the control means which adjust the direction of outgoing radiation of the laser beam which penetrates 2 wedge glass

[0022] That is, the laser survey equipment of the 2nd mode can arrange the wedge glass of two sheets on the optical path of a laser beam, and can adjust the sense of the beam shaft of a laser beam by rotating each wedge glass in the field which intersects perpendicularly with the optical path of the laser beam concerned. Thereby, like the 1st mode, the structure of laser survey equipment can be simplified and, moreover, the time of leveling-up work can be shortened.

[0023] such laser survey equipment of composition -- the [ the above 1st and ] -- you may have further a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects 90 degrees of laser beams which penetrated 2 wedge glass, and the aforementioned reflective member

[0024] Moreover, a beam division means to divide into two or more laser beams the laser beam to which outgoing radiation of the laser survey equipment of the 2nd mode was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ the above 1st and ] -- according to the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means, you may control rotation of 2 wedge glass

[0025] In case the laser survey equipment of each above-mentioned mode is used, the aforementioned beam division means may be a beam splitter which-reflects the remainder while penetrating a part of incident light, and the aforementioned optical position detection means may be a two-dimensional position sensitive detector (PSD).

[0026] Furthermore, the laser survey equipment of each above-mentioned mode may be further equipped with a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects other one [ 90-degree ] of the laser beams divided by the aforementioned beam division means, and the aforementioned reflective member. At this time, the aforementioned reflective member may be a pentaprism. Moreover, the tilt angle detected in the aforementioned level detector may be equivalent to the inclination to the vertical of the beam shaft of the laser beam which it is divided by the aforementioned beam division means, and carries out incidence to the aforementioned reflective member at this time.

[0027]

[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained based on a drawing.

<1st operation gestalt> drawing 1 is the cross section showing the composition of the floodlighting equipment which constitutes the laser survey equipment by the 1st operation gestalt of this invention. This drawing 1 shows the state of the floodlighting equipment when standing laser survey equipment in the perpendicular direction, in order to perform the laser beam scan to a horizontal direction.

[0028] Floodlighting equipment 11 is constituted from that rotation is free and the rotation floodlighting section 15 held at the same axle by the lens-barrel 14 through the lens-barrel 14 fixed in housing (not shown) of laser survey equipment, and bearing 19. Laser beam optical-path 14b in alignment with the machine shaft 1z (axis of rotation of the rotation floodlighting section 15 and coincidence) and laser beam optical-path 14a which intersects perpendicularly with this laser beam optical-path 14b are formed in the lens-barrel 14. Moreover, while it is open for free passage to laser beam optical-path 15a of the hollow formed in the axis of rotation and same axle while it was open for free passage to laser beam optical-path 14b, and this laser beam optical-path 15a, pentaprism stowage 15b which has opening is formed in the direction of an end face, and the side at the rotation floodlighting section 15.

[0029] (Laser outgoing radiation optical system) The beam splitter 24 as a beam division means is

being fixed to the intersection of the laser beam optical paths 14a and 14b in a lens-barrel 14. Moreover, the laser diode 21 is being fixed to one edge of this laser beam optical-path 14a. Moreover, between this laser diode 21 and beam splitter 24, a collimator lens 22, the ANAMO prism 23, and the beam shaft controller 33 are being fixed from the laser diode 21 side. Moreover, a pentaprism 27 and the wedge prism 30 are being fixed to pentaprism hold section 15b of the rotation floodlighting section 15.

[0030] The laser diode 21 as a laser light source carries out outgoing radiation of the laser beam L0. A collimator lens 22 is a lens which makes parallel light the laser beam L0 by which outgoing radiation was carried out from laser diode 21. Moreover, the ANAMO prism 23 is an optical element for correcting to a perfect circle form the cross-section configuration of the laser beam L0 which penetrated the collimator lens 22.

[0031] The laser beam L0 which penetrated the ANAMO prism 23 penetrates the optical-axis controller 33, and it carries out incidence to a beam splitter 24 (the optical-axis controller 33 is explained in full detail behind). In the beam splitter 24, partial transparency film 24a which inclined to the pentaprism 27 side 45 degrees to the beam shaft of a laser beam L0 is formed. It has the property of reflecting the remaining laser beam while it makes 20 - 30% of the laser beam L0 penetrate, since this partial transparency film 24a has 70 - 80% of reflection factor. Therefore, 70 - 80% of the laser beam L0 which penetrated the ANAMO prism 23 is reflected in a pentaprism 27 side.

[0032] Incidence of the laser beam L1 which reflected this beam splitter 24 is carried out to the pre-group lens 25 and the back group lens 26 which were fixed in laser beam optical-path 14b. These pre-group lens 25 and the back group lens 26 constitute the beam expander to which the beam diameter of the laser beam L1 by which incidence was carried out is expanded.

[0033] In pentaprism hold section 15b of the rotation floodlighting section 15, the pentaprism 27 in which the laser beam L1 which penetrated the back group lens 26 carries out incidence is being fixed so that it may rotate to this rotation floodlighting section 15 and one. Optical plane-of-incidence 27c to which a laser beam L1 carries out incidence of this pentaprism 27, 1st reflector 27a which the laser beam which carried out incidence from this optical plane-of-incidence 27c while 22.5 degrees leaned to this optical plane-of-incidence 27c reflects, 2nd reflector 27b which reflects again the laser beam reflected by this 1st reflector 27a while 45 degrees leaned to this 1st reflector 27a, While making the right angle to optical plane-of-incidence 27c, it has 27d of optical outgoing radiation sides which carry out outgoing radiation of the laser beam L3 reflected by 2nd reflector 27b. in addition, it does not illustrate to 2nd reflector 27b -- an increase -- reflection -- a film -- since it is formed of the vacuum plating of aluminium, in this 2nd reflector 27b, internal reflection of the laser beam is carried out 100% On the other hand, the partial transparency film whose reflection factor is 70 - 80% is formed in 1st reflector 27a. Therefore, 20 - 30% of laser beam L2 penetrates this 1st reflector 27a, and outgoing radiation is carried out from the upper limit of floodlighting equipment 12 through the wedge prism 30.

[0034] From 27d of optical outgoing radiation sides of a pentaprism 27, the laser beam L3 by which outgoing radiation was carried out penetrates aperture 15for floodlighting c which carried out opening, and the aperture of housing which is not illustrated to the side of pentaprism hold section 15b, and outgoing radiation is carried out to it. Thus, the laser beam L3 by which outgoing radiation was carried out projects the datum line perpendicular to a wall surface etc., or horizontal by rotating in the field where a laser beam L1 and a pentaprism 27 cross at right angles the whole rotation floodlighting section 15.

[0035] (Rolling mechanism) Next, the mechanism (rotation means) for rotating the rotation floodlighting section 15 to a lens-barrel 14 is explained. The gear 35 is being fixed to the peripheral face of the rotation floodlighting section 15 connected free [ rotation ] to the lens-barrel 14 through bearing 19. On the other hand, the bracket 36 made to project towards the method of outside is formed in the upper-limit side of a lens-barrel 14. The motor 37 for floodlighting section rotation is being fixed to this bracket 36, and the pinion 38 attached in the axis of rotation of this motor 37 for floodlighting section rotation has geared with the gear 35 of the rotation floodlighting section 15. Since the direction of outgoing radiation of the laser beam L3 by which outgoing radiation is carried out from aperture 15for floodlighting c by rotating this motor 37 for floodlighting section rotation

rotates focusing on the axis of rotation of the rotation floodlighting section 15, the base plane which intersects perpendicularly with this axis of rotation is formed.

[0036] (Leveling-up mechanism) As mentioned above, in order to project the datum line perpendicular to a wall surface etc., or horizontal by the laser beam L3, the direction of outgoing radiation of a laser beam L3 needs to be adjusted correctly. For example, in the state of drawing 1, it must be correctly projected on the laser beam L3 which projects the horizontal datum line horizontally. Hereafter, the leveling-up mechanism for adjusting the direction of outgoing radiation of such a laser beam L3 is explained.

[0037] Drawing 2 is drawing showing a part of each part material fixed to the lens-barrel 14 for explaining the leveling-up mechanism in the laser survey equipment 10 of drawing 1. Moreover, drawing 3 is the front view which looked at the beam shaft controller 33 from the beam-splitter 24 side, and drawing 4 is the cross section which met the A-A line of drawing 3. It is installed in the beam shaft controller 33 so that the circular abbreviation parallel glass 41 and 42 of two sheets as a transparent member may serve as abbreviation parallel mutually, and the periphery portion of these abbreviation parallel glass 41 and 42 is inserted in the annular glass presser-foot frames 45 and 46. 45d of receptacle seats for holding abbreviation parallel glass 41 is formed in the opening edge which counters the glass presser-foot frame 46 of the glass presser-foot frame 45. Similarly, 46d of receptacle seats for holding abbreviation parallel glass 42 is formed in the opening edge which counters the glass presser-foot frame 45 of the glass presser-foot frame 46.

[0038] Covering 43 (elastic member) has the shape of a cylindrical shape of the shape of bellows which consists of an elastic body, and both the openings edge is closed by pasting the receptacle seats 45d and 46d of the glass presser-foot frames 45 and 46, respectively. And the solution layer 44 is formed in the interior of covering 43 by filling up with liquids, such as a silicone oil.

[0039] On the peripheral face of the glass presser-foot frames 45 and 46, the pin attachment sections 45a and 46a of a rectangle tabular are formed at each glass presser-foot frames 45 and 46 and one. The both ends are formed more thinly than other portions, and the pin 47 is attached so that the pin attachment sections 45a and 46a may be penetrated. For this reason, the distance between each glass presser-foot frame 45 in the portion in which each pin attachment sections 45a and 46a were formed, and 46 is maintained at simultaneously regularity. However, each pin attachment sections 45a and 46a are movable to the shaft orientations of this pin 47 in some range to a pin 47.

[0040] Moreover, on the peripheral face of the glass presser-foot frame 45, two lead screw attaching parts 45b and 45c of a rectangle tabular are formed at this glass presser-foot frame 45 and one. These lead screw attaching parts 45b and 45c and pin attachment section 45a are formed so that it may project in the method of outside from 3 division-into-equal-parts position of the peripheral face of the glass presser-foot frame 45. And on the peripheral face which laps with lead screw attaching part 45b of the glass presser-foot frame 46, lead screw attaching part 46b is formed. Screw hole 46e is formed in lead screw attaching part 46b, and the lead screw 48 is thrust into this screw hole 46e.

[0041] The lead screw 48 is formed more thinly than other portions, and it has edge 48a by which the male screw is not turned off, and this edge 48a is inserted in lead screw attaching part 45b free [rotation]. Since the stopper ring 55 has fitted in, the lead screw 48 is held at edge 48a which penetrated lead screw attaching part 45b so that it may not fall out from lead screw attaching part 45b. And the lead screw 48 rotates through the motor gear 52 which meshes with the lead screw gear 53 fixed at the nose of cam, and this lead screw gear 53 by the motor 51 fixed to lead screw attaching part 45b. Drive control of this motor 51 is carried out by the control section 35. Lead screw attaching part 46b is moved with rotation of the lead screw 48 by this motor 51 in accordance with the shaft orientations (the direction of B of drawing 4) of the lead screw 48. For this reason, the distance between each abbreviation parallel glass 42 in the portion in which the lead screw attaching parts 45b and 46b were formed, and 43 changes. Moreover, the same mechanism as the lead screw attaching parts 45b and 46b is established also about the lead screw attaching parts 45c and 46c. For this reason, the distance between each abbreviation parallel glass 42 in the portion in which lead screw attaching part 45c was formed, and 43 also changes with control sections 35.

[0042] The situation of the optical-axis controller 33 when a motor 51 rotates to drawing 5 is shown. As mentioned above, when a motor 51 rotates, the lead screw 48 rotates and lead screw attaching part 46b moves in accordance with the shaft of this lead screw 48 in connection with this. For this

reason, as shown in drawing 5, the distance between each abbreviation parallel glass 41 in this portion and 42 becomes small. On the other hand, the distance between each abbreviation parallel glass 41 in the portion in which each pin attachment sections 45a and 46a were formed, and 42 is kept constant by the pin 47. Therefore, each abbreviation parallel glass 41 and 42 will be in the state of countering with some angle from parallel. At this time, the angle (namely, vertical angle of a solution layer 44) which each abbreviation parallel glass 41 and 42 makes is made into  $\theta^{**}$ , and the refractive index of a solution layer 44 is set to  $n$  (however,  $n^{**}1.5$ ). And if the angle of deviation of the beam shaft of the laser beam L0 by which carries out incidence to abbreviation parallel glass 42, and penetrates a solution layer 44 and outgoing radiation is carried out from abbreviation parallel glass 41 is made into  $\theta^{**}$ , the relation of the following formula will be realized.

$$\theta^{*} = (n-1) \theta \dots (1)$$

That is, the sense of the beam shaft of the laser beam L0 which penetrates this beam shaft controller 33 can be changed by controlling the size of the vertical angle  $\theta$  of a solution layer 44.

[0043] Moreover, as shown in drawing 1 and drawing 2, the two-dimensional position sensitive detector (henceforth "PSD") 29 as an optical position detection means turns the light-receiving side to a beam-splitter 24 side, and is being fixed to the end face which counters the laser diode 21 of laser beam optical-path 14a of a lens-barrel 14. moreover, two-dimensional [ in laser beam optical-path 14a ] -- the condenser lens 28 is being fixed between PSD29 and the beam splitter 24. The distance between two-dimensional PSD(s)29 is equal to the focal distance  $f_2$  of a condenser lens 28 in this condenser lens 28. Therefore, 20 - 30% of laser beam L4 which penetrated partial transparency film 24a among the laser beams L0 which outgoing radiation was carried out from laser diode 21, and carried out incidence to the beam splitter 24 penetrates a condenser lens 28, and is condensed on PSDtwo-dimensional 29. Two-dimensional PSD29 is a device which detects the incidence position of light. The incidence position of the laser beam L4 to two-dimensional PSD is computed based on the current ratio outputted from each of this output terminal of two-dimensional PSD29. In addition, each of this output terminal of two-dimensional PSD is connected to the control section 35.

[0044] Moreover, the tilt sensor 31 (level detector) which detects the inclination of the level shell of x directions (hand of cut within space) is being fixed to the soffit section of laser beam optical-path 14b of a lens-barrel 14. And the tilt sensor 32 which detects the inclination of the level shell (hand of cut in the field which intersects perpendicularly with space along the perpendicular direction) of y is being fixed to the side of the tilt sensor 31. The tilt sensors 31 and 32 detect the inclination of a level shell by regarding position change of the foam in the bubble tube with which the electrolytic solution was filled as a change in resistance, and changing into an electrical signal. That is, while two electrodes (not shown) are prepared in the detection direction of a tilt angle by object physical relationship, respectively, the common electrode is prepared in the inferior-surface-of-tongue whole region on the upper surface of the tilt sensors 31 and 32. Therefore, if the position of a foam changes within each tilt sensor 31 and 32, the ratio of the resistance between each electrode on these upper surfaces and a common electrode will change. Each tilt sensors 31 and 32 are connected to the control section 35 through each [ these ] electrode, and the variation of the inclination of a lens-barrel 14 is computed based on change of the ratio of the resistance produced in each electrode.

[0045] By using the measuring device which is not illustrated in the state of drawing 2, the sense of a lens-barrel 14 shall be adjusted so that outgoing radiation of the laser beam L3 may be carried out horizontally correctly and outgoing radiation of the laser beam L1 may be carried out in the perpendicular direction I0. In addition, the beam shaft of a laser beam L1 and the machine shaft IZ of a lens-barrel 14 shall be completely in agreement at this time. the measured value of the tilt sensors 31 and 32 at this time, and two-dimensional [ of a laser beam L4 ] -- the incidence position of PSD29 is memorized as initial value to a control section two-dimensional [ at this time / of a laser beam L4 ] -- distance in the x directions of [ from the PSD center coordinate  $a_0$  of the incidence position of PSD29 ] is set to  $a_1$ . Here, since the lens-barrel machine shaft IZ and the perpendicular direction I0 are in the state which was completely in agreement, although a value when the measured value by each tilt sensors 31 and 32 has the perpendicular machine shaft IZ of a lens-barrel 14 is shown, depending on the physical relationship of the lens-barrel machine shaft IZ and the beam shaft of a laser beam L1, this measured value does not necessarily need to show the value at the time of a



vertical.

[0046] Since the beam shaft of a laser beam L1 is perpendicular since the beam shaft of drawing 6 of the laser beam L3 by which outgoing radiation was carried out from 27d of optical outgoing radiation sides of a pentaprism 27 from the state of drawing 2 was level when it  $+\Delta\omega$ . Inclines in the x directions namely, the state  $+\Delta\omega$ . Where it inclined is shown (the clockwise sense is made into + in the x directions of drawing 6). Since it is in the state  $+\Delta\omega$ . Where the machine shaft lz of a lens-barrel 14 inclined from the state of drawing 2 to the perpendicular direction l0 similarly, at this time, the measured value of the tilt sensor 31 also changes from initial value by the inclination of  $+\Delta\omega$ .

[0047] Then, the measured value of the tilt sensor 31 is read by the control section 35. A control section 35 computes amount of inclinations  $+\Delta\omega$  of the beam shaft of a laser beam L1 based on the measured value of the tilt sensor 31. Since the motors 51 and 51 of each lead screw attaching parts 45b and 45c of the beam shaft controller 33 rotate and the lead screws 48 and 48 opened for free passage through the motor gears 52 and 52 and the lead screw gears 53 and 53 rotate according to it, respectively, the lead screw attaching parts 46b and 46c are moved to the shaft orientations of the lead screws 48 and 48. Since the size of the vertical angle theta which a solution layer 44 forms changes by this, the direction of outgoing radiation of the beam shaft of a laser beam L1 is adjusted. When the size of the vertical angle theta of a solution layer 44 changes to drawing 7 shows signs that it was adjusted so that the beam shaft of a laser beam L1 might become in the perpendicular direction l0. In order to adjust so that outgoing radiation of the laser beam L1 may be carried out in the perpendicular direction l0, only  $+\Delta\omega$  needs to make the beam shaft of the laser beam L0 by which outgoing radiation is carried out incline from the beam shaft controller 33 to the optical axis of a collimator lens 22. two-dimensional [ of the laser beam / in / x directions / when the  $+\Delta\omega$  inclination of the beam shaft of a laser beam L0 is done to the optical axis of a collimator lens 22 ]  $L4 / --$  the amount b of gaps from the initial value a1 of the incidence position of PSD29 serves as  $b = f \tan(+\Delta\omega)$ . Drive control of each motors 51 and 51 is carried out. therefore, the control section 33 -- two-dimensional, always carrying out the monitor of the incidence position of the laser beam L4 outputted from PSD29. The vertical angle theta of the solution layer 44 of the beam shaft controller 33 is changed so that the gap of the x directions of [ from the main coordinate a0 of the incidence position of a laser beam L4 ] which carries out incidence to two-dimensional PSD29 may serve as  $a1 + b = a1 + f \tan(+\Delta\omega)$ . The vertical angle theta of the solution layer 44 at this time is  $\theta = \theta' / (n-1)$  from (1) formula.  $= \Delta\omega / (n-1)$  (however, n refractive index of a solution layer 44)

It changes so that it may become. Thereby, only  $-\Delta\omega$  inclines from the state of drawing 6, and the beam shaft of a laser beam L1 is in agreement with the perpendicular direction l0. Therefore, it is adjusted so that the beam shaft of the laser beam L3 by which outgoing radiation is carried out from the rotation floodlighting section 15 may become level.

[0048] In addition, although only adjustment of the x directions of the inclination of the beam shaft of a laser beam L1 detected by the tilt sensor 31 was explained, adjustment of the beam shaft of the direction of y detected by the tilt sensor 32 is performed similarly here.

[0049] That is, with the laser survey equipment of this operation gestalt, the direction of outgoing radiation of a laser beam L1 is adjusted by adjusting the size of the vertical angle theta of the solution layer 44 of the beam shaft controller 33 according to the inclination of the level shell of the base plane formed of a laser beam L3. moreover, two-dimensional [ which installed change of the sense of each beam shaft at the time of making the beam shaft controller 33 drive on the optical axis of a collimator lens 22 ] -- it is supervising with the incidence position of the laser beam L4 of PSD29. For this reason, variation with the slight sense of the beam shaft L0 by the beam shaft controller 33 can be adjusted with high precision.

[0050] Thus, since the laser survey equipment of this operation gestalt is performing the leveling up by changing the relative angle of the abbreviation parallel glass 41 and 42 of two sheets which closed the solution layer 44, it does not need the complicated structure for leaning the whole lens-barrel like before. For this reason, structure of laser survey equipment can be simplified. Moreover, since the laser survey equipment of this operation gestalt does not need to lean floodlighting equipment 11 to housing in the case of a leveling up, the measured value of the tilt sensors 31 and 32



does not change in the middle of leveling-up work. Therefore, since time for stabilizing the measured value of a tilt sensor is not needed like before, leveling-up work can be done in a short time.

[0051] The leveling-up mechanism of the laser survey equipment in the 2nd operation gestalt of this invention and some laser outgoing radiation optical system are shown in <2nd operation gestalt> drawing 8. A \*\*\*\* 2 operation gestalt is applied, when leaning 90 degrees of lens-barrels 14 in the perpendicular direction and using them for it to the state of drawing 1, in order to carry out a laser scan.

[0052] Where 90 degrees is leaned in the x directions to the state of drawing 1, the tilt sensor 61 of x directions (hand of cut within space) is being fixed so that the beam shaft orientations of a laser beam L1 may become horizontal direction 10'. and the 1st operation gestalt -- the same -- the tilt sensor 61 of x directions -- the beam shaft controller 33 and two-dimensional -- it connects with the control section 53 with PSD29.

[0053] Hereafter, operation of the leveling-up mechanism of the laser survey equipment of this operation gestalt is explained. First, a control section 53 remembers the incidence position of the laser beam L4 to two-dimensional PSD29 to be the measured value of the tilt sensor 61 when being adjusted like drawing 8, so that the beam shaft of a laser beam L1 may become horizontal direction 10'. In addition, the beam shaft of a laser beam L1 and machine shaft lz' of a lens-barrel 14 shall be completely in agreement at this time. this time -- two-dimensional [ of a laser beam L4 ] -- distance in the x directions of [ from the PSD center a0 of the incidence position of PSD29 ] is set to  $a2 + \Delta\omega$ . As shown in drawing 9, the beam shaft of a laser beam L1 in the x directions from horizontal direction 10' and when it shifts a control section 53 -- two-dimensional -- so that the distance from the PSD center a0 of the incidence position of the x directions of the laser beam L4 of PSD29 may serve as  $a2 + f2 \tan(\Delta\omega)$ . The angle of the abbreviation parallel glass 42 to the abbreviation parallel glass 41 of the beam shaft controller 33 is changed, and the beam shaft orientation of a laser beam L0 is adjusted. Thus,  $-\Delta\omega$  rotation [ state / of drawing 9 ] of the beam shaft of a laser beam L1 can be done, and it can adjust so that horizontal direction 10' may be made to turn to (refer to drawing 10).

[0054] Thus, in order to perform the laser scan of the perpendicular direction, even when using laser survey equipment with this operation form, turning it horizontally, leveling-up work is done using the beam shaft controller 33 to which the beam shaft orientation of a laser beam L0 is adjusted by changing the relative angle of the abbreviation parallel glass 41 and 42 of two sheets which closed the solution layer 44 like the 1st operation form. Thereby, the sense of the beam shaft of a laser beam L0 is made to incline to lens-barrel machine shaft lz', and it can adjust so that the beam shaft of a laser beam L1 may become level.

[0055] <3rd operation gestalt> drawing 11 is the cross section showing the structure of the beam shaft controller 63 in the laser survey equipment of the 3rd operation gestalt of this invention. the laser survey equipment of a \*\*\*\* 3 operation gestalt does leveling-up work by adjusting the sense of the beam shaft of a laser beam L0 by rotating the optical axis of a collimator lens 22 for the wedge glass of two sheets as a center, respectively -- the feature -- carrying out -- other portions -- the [ the 1st and ] -- suppose that it is the same as that of 2 operation gestalten

[0056] The beam shaft controller 63 fixed in laser beam optical-path 14a of a lens-barrel 14 consists of casing 66 of an enclosed type which consists of a transparent member, and wedge glass 64 and 65 of two sheets held in this casing 66. Wedge glass 64 and 65 is an optical element which consists of a flat surface which faced with the angle more slightly than parallel, and it arranges and it is arranged so that those plane of incidence may be turned to a laser diode 21 side. It is held in casing 66 in the state which each [ these ] wedge glass 64 and 65 can rotate freely in a field perpendicular to the optical axis of a collimator lens 22. Moreover, 64 of each wedge glass and the axis of rotation of 65 are constituted so that it may be in agreement with the optical axis of a collimator lens 22. Gears 67 and 68 have fitted into the periphery portion of each [ these ] wedge glass 64 and 65, respectively, and each gears 67 and 68 are rotated by the motors 69 and 70 fixed in casing 66 into it. Each [ these ] motors 69 and 70 are connected to the control section 35, and the roll control of each wedge glass 64 and 65 is made by this control section 35. In addition, with this operation gestalt, each gears 67 and 68 and each motors 69 and 70 are combined, and it is considering as the "rolling mechanism."

[0057] When incidence of the laser beam L0 is carried out to this beam shaft controller 63, the beam shaft of this laser beam L0 is crooked by penetrating the wedge glass 64 and 65 of two sheets. And if each wedge glass 64 and 65 rotates by the control section 35, the sense of the beam shaft of the laser beam L0 which penetrates the beam shaft controller 63 will change. Thus, by adjusting the sense of the beam shaft of a laser beam L0, it can adjust so that outgoing radiation of the beam shaft of a laser beam L1 may be carried out in the perpendicular direction 10.

[0058] Hereafter, the leveling-up method of the laser survey equipment of this operation gestalt using the beam shaft controller 63 of the above-mentioned composition is explained using drawing 2, and 6, 7 and 11. As mentioned above, the sense of a lens-barrel 14 is adjusted so that outgoing radiation of the laser beam L3 may be horizontally carried out correctly by the measuring device which is not illustrated and outgoing radiation of the laser beam L1 may be carried out in the perpendicular direction 10 (at this time, the beam shaft of a laser beam L1 and the machine shaft 1z of a lens-barrel 14 are completely in agreement). the measured value of the tilt sensors 31 and 32 at this time, and two-dimensional [ of a laser beam L4 ] -- the incidence position of PSD29 is memorized by the control section 35 the 1st operation gestalt -- the same -- two-dimensional [ of the laser beam L4 at this time ] -- distance from the PSD center a0 of the incidence position of PSD29 is set to a1. As shown in drawing 6, the beam shaft of a laser beam L1 receives in the perpendicular direction 10.  $+\Delta\omega^{**}$  and when it shifts The roll control of each motors 69 and 70 is performed. a control section 35 -- two-dimensional -- so that the distance from the PSD center a0 of the incidence position of the x directions of the laser beam L4 of PSD29 may serve as  $a1 + f2 \tan(+\Delta\omega^{**})$  The sense of the beam shaft of the laser beam L0 by which incidence is carried out to a beam splitter 24 is adjusted by rotating each wedge glass 64 and 65 in the field which intersects perpendicularly with the optical axis of a collimator lens 22. Thus,  $-\Delta\omega^{**}$  rotation [ state / of drawing 6 ] of the beam shaft of a laser beam L1 can be done, and it can adjust so that the perpendicular direction 10 may be made to turn to ( drawing 7 ).

[0059] In addition, although the leveling-up mechanism at the time of standing laser survey equipment perpendicularly and using it like drawing 1 was explained in order to perform a horizontal laser scan here, in case the laser scan to the perpendicular direction is performed, the same leveling-up work can be done by fixing, where 90 degrees of tilt sensors 31 are rotated from the state of drawing 1 like the 2nd operation gestalt.

[0060]

[Effect of the Invention] According to this invention, a complicated leveling-up mechanism is not needed but the structure of laser survey equipment can be simplified. Moreover, the laser survey equipment which can do leveling-up work in a short time can be offered.

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TECHNICAL FIELD

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[The technical field to which invention belongs] this invention relates the datum line by the laser beam to horizontal or the laser survey equipment projected perpendicularly to a predetermined field.

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## PRIOR ART

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[Description of the Prior Art] Conventionally, in fields, such as engineering works and construction, the laser survey equipment (the so-called laser planar) for performing marking of a horizontal line or a vertical line is used. This laser equipment rotates the floodlighting section which carries out outgoing radiation of the laser beam, scans this laser beam to a hoop direction, and projects the datum line perpendicular to planes of incidence, such as a wall surface, or horizontal by tracing of a laser beam.

[0003] Drawing 12 is the cross section showing the composition of conventional laser survey equipment. This drawing 12 shows the state where laser survey equipment was stood in the perpendicular direction, in order to perform the laser beam scan to a horizontal direction. The lens-barrel 82 dedicated in housing 81 consists of laser beam optical-path 82a of the hollow which branched at the right angle from laser beam optical-path 82b of the hollow which penetrates the whole along with the medial axis of laser survey equipment, and this laser beam optical-path 82b. In laser beam optical-path 82a, a laser diode 83, the collimator lens unit 104, and the ANAMO prism 84 are being fixed from the end-face side. And the rectangular prism 85 is being fixed to the intersection of the laser beam optical paths 82a and 82b.

[0004] In laser beam optical-path 82b, the pre-group lens 86 and the back group lens 87 are being fixed toward the upper part in drawing 12 from the rectangular prism 85. The approximate circle tubed rotation floodlighting section 88 to which the pentaprism 89 was dedicated is being fixed to the upper-limit section of a lens-barrel 82 free [ rotation ] in the field which intersects perpendicularly with laser beam optical-path 82b. Opening is formed in the upper-limit side and the side of this rotation floodlighting section 88, respectively.

[0005] In the laser survey equipment of such composition, if outgoing radiation of the laser beam L10 is carried out from the laser diode 83 fixed to the laser beam optical-path 82a end face, in a rectangular prism 85, 90 degrees of the laser beam L10 will be crooked in the rotation floodlighting section 88 side, it will penetrate the pre-group lens 86 and the back group lens 87, and they will carry out incidence to a pentaprism 89. The laser beam L10 which carried out incidence to the pentaprism 89 is gradually reflected by 2nd reflector 89b which inclined 45 degrees to 1st reflector 89a and this 1st reflector. And outgoing radiation of the laser beam L11 which reflector [ 1st ] 89a Reached and was reflected by 2nd reflector 89b is carried out from optical outgoing radiation side 89c which is making the right angle to 89d of optical plane of incidence.

[0006] Moreover, the partial reflection film is formed in 1st reflector 89a. Therefore, some laser beams L12 penetrate this 1st reflector 89a, penetrate the wedge prism 90 fixed on this 1st reflector 89a, and outgoing radiation is carried out from opening of a rotation floodlighting section 88 upper-limit side.

[0007] And a laser beam L11 rotates focusing on the axis of rotation of the rotation floodlighting section 88 by rotating in the field where laser beam optical-path 82b and the rotation floodlighting section 88 cross at right angles. Therefore, the base plane which intersects perpendicularly with this axis of rotation is formed of a laser beam L11. Moreover, the laser beam L12 by which outgoing radiation is carried out from the upper limit of the rotation floodlighting section 88 forms the criteria spot for a survey control point etc. being shown in a ceiling etc.

[0008] Thus, in order to form a base plane in a wall surface etc., outgoing radiation of the laser beam L11 by which outgoing radiation was carried out from laser survey equipment needs to be carried out

horizontally correctly. Similarly, outgoing radiation also of the laser beam L12 which forms a criteria spot needs to be correctly carried out to a ceiling etc. perpendicularly. Therefore, at the time of use of laser survey equipment, it is necessary to do leveling-up work so that outgoing radiation of the laser beam L11 may be carried out horizontally correctly.

[0009] Hereafter, the leveling-up mechanism for outgoing radiation of the laser beam L11 being carried out horizontally correctly is explained. sliding which the bulge section 91 which has a semi-sphere side configuration is formed in the upper-limit side of a lens-barrel 82, and was formed in housing 81 -- a hole -- it is held in the state where it contacted in 81a since the maintenance to the housing 81 of a lens-barrel 82 is made by only contact of this portion -- sliding -- a hole -- the lens-barrel 82 whole can be made to tilt in all the directions by rotating the semi-sphere side portion of the bulge section 91 within 81a

[0010] Moreover, in housing 81, the screw 97 rotated by the motor 98 for level adjustment is formed. The nut 99 is screwed in this screw 97. This nut 99 moves up and down with rotation of a screw 97. The operation pin 101 is projected and formed in the superficies of a nut 99. The drive arm 96 formed in the bulge section 91 and the pin 100 open for free passage touch the operation pin 101, and, thereby, rotation of the direction of X of the bulge section 91 (hand of cut within space) is regulated.

[0011] Furthermore, under the rectangular prism 85, the tilt sensor 103 of the direction of X which detects the inclination of the direction of X of a lens-barrel 82 is being fixed in the lens-barrel 82. According to the inclination detected by this tilt sensor 103, the roll control of the motor 98 for level adjustment is performed, and a screw 97 rotates by this. Then, a nut 99 moves up and down with rotation of this screw 97, and the bulge section 91 linked through the operation pin 101 and the pin 100 rotates in the direction of X. In addition, the tilt sensor 102 of the direction of Y which detects the inclination of the direction (hand of cut in the field which intersects perpendicularly with space along the perpendicular-among drawing direction) of Y is being fixed to the side of the tilt sensor of the direction of X. Moreover, although not shown in the drawing, in housing 81, the mechanism for regulating rotation of the direction of Y of the bulge section 91 as well as the direction of X is established according to the size of the inclination detected by the tilt sensor 102. Thus, it is adjusted so that a lens-barrel 82 may always turn to the perpendicular direction, namely, so that outgoing radiation of the laser beam L11 may always be carried out horizontally. Therefore, a laser beam L11 can form always exact datum level.

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EFFECT OF THE INVENTION

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[Effect of the Invention] According to this invention, a complicated leveling-up mechanism is not needed but the structure of laser survey equipment can be simplified. Moreover, the laser survey equipment which can do leveling-up work in a short time can be offered.

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] However, with the structure of conventional laser survey equipment which was mentioned above, the leveling-up work for carrying out outgoing radiation of the laser beam L11 horizontally is done by leaning a lens-barrel 82 using the motor 98 for level adjustment, a screw 97, and nut 99 grade. For this reason, there was a problem that the structure of laser survey equipment will become complicated.

[0013] Moreover, if an inclination changes, the tilt sensor 102,103 will require fixed time until the measured value is stabilized possible [ measurement ]. For this reason, you have to wait to stabilize the measured value of the tilt sensor 102,103, whenever the inclination of a lens-barrel 82 changes, when adjustment by leaning a lens-barrel 82 like before is performed. For this reason, the long time was required in order to do leveling-up work.

[0014] Then, structure for a leveling up can be simplified and let it be the technical problem of this invention to offer the laser survey equipment which can moreover do leveling-up work in a short time.

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MEANS

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[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the 1st mode of the laser survey equipment of this invention the [ which has been arranged on the optical path of the laser beam by which outgoing radiation was carried out from the laser light source and the aforementioned laser light source / abbreviation plate-like / the 1st and ] -- with 2 transparent member the [ the above 1st and ] -- with the tubed elastic member by which the double door peristome was closed by 2 transparent member the [ the solution layer formed by filling up with a liquid in the aforementioned elastic member, and / the above 1st and ] -- with the lens-barrel holding 2 transparent member The adjustment mechanism the above 1st held at this lens-barrel and whose adjustment in the range which includes parallel for the relative tilt angle of a member the 2nd transparence are enabled, The aforementioned adjustment mechanism is controlled according to the size of the aforementioned tilt angle detected in the level detector which detects the tilt angle to the level surface of the aforementioned lens-barrel, and the aforementioned level detector, and it has the control means which adjust the size of the angle which the aforementioned 1st area-pellucida material and the aforementioned 2nd area-pellucida material make.

[0016] That is, the unit which closed the elastic member by the 1st and 2nd transparent members, and filled up the liquid with the laser survey equipment of the 1st mode into it is arranged on the optical path of a laser beam. And the sense of the beam shaft which penetrates each [ these ] transparent member is changed by changing the angle which each transparent member makes according to the size of the inclination of the level shell of the lens-barrel detected in the level detector. Therefore, since it is not necessary to establish like before the complicated leveling-up mechanism in which a lens-barrel is leaned, the structure of laser survey equipment can be simplified. Moreover, with the laser survey equipment of the 1st mode, since it is accepted by changing the size of the angle which each transparent member makes and the sense of a beam shaft is adjusted, it is not necessary to change the sense of the whole lens-barrel. Therefore, since the measured value of a level detector is always fixed, in case it does leveling-up work like before through leveling-up work, it does not require time until the measured value of a level detector is stabilized. Therefore, the time of leveling-up work can be shortened.

[0017] In case the laser survey equipment of such composition is used, it is good also as what has a bellows-like configuration for the aforementioned elastic member, and is good also considering the liquid which forms the aforementioned solution layer as a silicone oil.

[0018] moreover, the laser survey equipment of the above-mentioned composition -- the [ the above 1st and ] -- you may have further a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects 90 degrees of laser beams which penetrated 2 transparent member, and the aforementioned reflective member

[0019] Furthermore, a beam division means to divide into two or more laser beams the laser beam to which outgoing radiation of the laser survey equipment of the above-mentioned composition was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ aforementioned ] -- the [ 1 transparent member and /



aforementioned ] -- based on the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means, you may compute the size of the angle which 2 transparent member makes

[0020] If the laser survey equipment of such composition is adopted, the size of the angle which each transparent member makes can be made to be able to respond to the variation of the incidence position to the optical position sensing element of the beam divided by the beam division means, and can be detected. Therefore, the sense of a beam shaft can be adjusted more precisely.

[0021] Moreover, the 2nd mode of the laser survey equipment of this invention A laser light source and the 1st wedge glass which penetrates the laser beam by which outgoing radiation was carried out from the aforementioned laser light source while being held in a lens-barrel possible [ rotation ] centering on the beam shaft of this laser beam, The 2nd wedge glass which penetrates the laser beam which penetrated the aforementioned 1st wedge glass while being held in a lens-barrel possible [ rotation ] centering on the beam shaft of the aforementioned laser beam, the [ the above 1st held in the aforementioned lens-barrel, and ] -- with the rolling mechanism which rotates 2 wedge glass the size of the aforementioned tilt angle detected in the level detector which detects the tilt angle to the level surface of the aforementioned lens-barrel, and the aforementioned level detector -- responding - the aforementioned rolling mechanism -- controlling -- the [ the above 1st and ] -- it has the control means which adjust the direction of outgoing radiation of the laser beam which penetrates 2 wedge glass

[0022] That is, the laser survey equipment of the 2nd mode can arrange the wedge glass of two sheets on the optical path of a laser beam, and can adjust the sense of the beam shaft of a laser beam by rotating each wedge glass in the field which intersects perpendicularly with the optical path of the laser beam concerned. Thereby, like the 1st mode, the structure of laser survey equipment can be simplified and, moreover, the time of leveling-up work can be shortened.

[0023] such laser survey equipment of composition -- the [ the above 1st and ] -- you may have further a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects 90 degrees of laser beams which penetrated 2 wedge glass, and the aforementioned reflective member

[0024] Moreover, a beam division means to divide into two or more laser beams the laser beam to which outgoing radiation of the laser survey equipment of the 2nd mode was carried out from the aforementioned laser light source, The condenser lens which condenses one of the laser beams divided by the aforementioned beam division means, It is arranged on the focal plane of the aforementioned condenser lens, and has further an optical position detection means to detect the incidence position of the laser beam condensed with the aforementioned condenser lens. the aforementioned control means -- the [ the above 1st and ] -- according to the variation of the incidence position of the aforementioned laser beam which carried out incidence to the aforementioned optical position detection means, you may control rotation of 2 wedge glass

[0025] In case the laser survey equipment of each above-mentioned mode is used, the aforementioned beam division means may be a beam splitter which reflects the remainder while penetrating a part of incident light, and the aforementioned optical position detection means may be a two-dimensional position sensitive detector (PSD).

[0026] Furthermore, the laser survey equipment of each above-mentioned mode may be further equipped with a rotation means to rotate the direction of outgoing radiation of the laser beam deflected by this reflective member within a fixed flat surface, by rotating the reflective member which deflects other one [ 90-degree ] of the laser beams divided by the aforementioned beam division means, and the aforementioned reflective member. At this time, the aforementioned reflective member may be a pentaprism. Moreover, the tilt angle detected in the aforementioned level detector may be equivalent to the inclination to the vertical of the beam shaft of the laser beam which it is divided by the aforementioned beam division means, and carries out incidence to the aforementioned reflective member at this time.

[0027]

[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained based on a drawing.

<1st operation gestalt> drawing 1 is the cross section showing the composition of the floodlighting equipment which constitutes the laser survey equipment by the 1st operation gestalt of this invention. This drawing 1 shows the state of the floodlighting equipment when standing laser survey equipment in the perpendicular direction, in order to perform the laser beam scan to a horizontal direction.

[0028] Floodlighting equipment 11 is constituted from that rotation is free and the rotation floodlighting section 15 held at the same axle by the lens-barrel 14 through the lens-barrel 14 fixed in housing (not shown) of laser survey equipment, and bearing 19. Laser beam optical-path 14b in alignment with the machine shaft 1z (axis of rotation of the rotation floodlighting section 15 and coincidence) and laser beam optical-path 14a which intersects perpendicularly with this laser beam optical-path 14b are formed in the lens-barrel 14. Moreover, while it is open for free passage to laser beam optical-path 15a of the hollow formed in the axis of rotation and same axle while it was open for free passage to laser beam optical-path 14b, and this laser beam optical-path 15a, pentaprism stowage 15b which has opening is formed in the direction of an end face, and the side at the rotation floodlighting section 15.

[0029] (Laser outgoing radiation optical system) The beam splitter 24 as a beam division means is being fixed to the intersection of the laser beam optical paths 14a and 14b in a lens-barrel 14. Moreover, the laser diode 21 is being fixed to one edge of this laser beam optical-path 14a. Moreover, between this laser diode 21 and beam splitter 24, a collimator lens 22, the ANAMO prism 23, and the beam shaft controller 33 are being fixed from the laser diode 21 side. Moreover, a pentaprism 27 and the wedge prism 30 are being fixed to pentaprism hold section 15b of the rotation floodlighting section 15.

[0030] The laser diode 21 as a laser light source carries out outgoing radiation of the laser beam L0. A collimator lens 22 is a lens which makes parallel light the laser beam L0 by which outgoing radiation was carried out from laser diode 21. Moreover, the ANAMO prism 23 is an optical element for correcting to a perfect circle form the cross-section configuration of the laser beam L0 which penetrated the collimator lens 22.

[0031] The laser beam L0 which penetrated the ANAMO prism 23 penetrates the optical-axis controller 33, and it carries out incidence to a beam splitter 24 (the optical-axis controller 33 is explained in full detail behind). In the beam splitter 24, partial transparency film 24a which inclined to the pentaprism 27 side 45 degrees to the beam shaft of a laser beam L0 is formed. It has the property of reflecting the remaining laser beam while it makes 20 - 30% of the laser beam L0 penetrate, since this partial transparency film 24a has 70 - 80% of reflection factor. Therefore, 70 - 80% of the laser beam L0 which penetrated the ANAMO prism 23 is reflected in a pentaprism 27 side.

[0032] Incidence of the laser beam L1 which reflected this beam splitter 24 is carried out to the pre-group lens 25 and the back group lens 26 which were fixed in laser beam optical-path 14b. These pre-group lens 25 and the back group lens 26 constitute the beam expander to which the beam diameter of the laser beam L1 by which incidence was carried out is expanded.

[0033] In pentaprism hold section 15b of the rotation floodlighting section 15, the pentaprism 27 in which the laser beam L1 which penetrated the back group lens 26 carries out incidence is being fixed so that it may rotate to this rotation floodlighting section 15 and one. Optical plane-of-incidence 27c to which a laser beam L1 carries out incidence of this pentaprism 27, 1st reflector 27a which the laser beam which carried out incidence from this optical plane-of-incidence 27c while 22.5 degrees leaned to this optical plane-of-incidence 27c reflects, 2nd reflector 27b which reflects again the laser beam reflected by this 1st reflector 27a while 45 degrees leaned to this 1st reflector 27a, While making the right angle to optical plane-of-incidence 27c, it has 27d of optical outgoing radiation sides which carry out outgoing radiation of the laser beam L3 reflected by 2nd reflector 27b. in addition, it does not illustrate to 2nd reflector 27b -- an increase -- reflection -- a film -- since it is formed of the vacuum plating of aluminium, in this 2nd reflector 27b, internal reflection of the laser beam is carried out 100% On the other hand, the partial transparency film whose reflection factor is 70 - 80% is formed in 1st reflector 27a. Therefore, 20 - 30% of laser beam L2 penetrates this 1st reflector 27a, and outgoing radiation is carried out from the upper limit of floodlighting equipment 12 through the wedge prism 30.

[0034] From 27d of optical outgoing radiation sides of a pentaprism 27, the laser beam L3 by which

outgoing radiation was carried out penetrates aperture 15 for floodlighting c which carried out opening, and the aperture of housing which is not illustrated to the side of pentaprism hold section 15b, and outgoing radiation is carried out to it. Thus, the laser beam L3 by which outgoing radiation was carried out projects the datum line perpendicular to a wall surface etc., or horizontal by rotating in the field where a laser beam L1 and a pentaprism 27 cross at right angles the whole rotation floodlighting section 15.

[0035] (Rolling mechanism) Next, the mechanism for rotating the rotation floodlighting section 15 to a lens-barrel 14

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[Translation done.]

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DESCRIPTION OF DRAWINGS

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## [Brief Description of the Drawings]

[Drawing 1] The cross section showing the structure of the laser survey equipment by the 1st operation gestalt of this invention

[Drawing 2] Drawing for explaining the leveling-up mechanism of the laser survey equipment by the 1st operation gestalt of this invention

[Drawing 3] Front view of the beam shaft controller 33 in the laser survey equipment by the 1st operation gestalt of this invention

[Drawing 4] The cross section which met the A-A line of drawing 3

[Drawing 5] The cross section showing the state of the beam shaft controller 33 when rotating a motor 51

[Drawing 6] Drawing showing signs +deltaomega\*\* That the beam shaft of a laser beam L1 inclined from the state of drawing 2

[Drawing 7] Drawing showing signs that leveling-up work was done from the state of drawing 6

[Drawing 8] Drawing for explaining the leveling-up mechanism of the laser survey equipment by the 2nd operation gestalt of this invention

[Drawing 9] Drawing showing signs +deltaomega\*\* That the beam shaft of a laser beam L1 inclined from the state of drawing 8

[Drawing 10] Drawing showing signs that leveling-up work was done from the state of drawing 9

[Drawing 11] The cross section showing the structure of the beam shaft controller 63 in the laser survey equipment of the 3rd operation gestalt of this invention

[Drawing 12] The cross section showing the structure of the laser survey equipment of the conventional technology

## [Description of Notations]

- 21 Laser Diode
- 22 Collimator Lens
- 24 Beam Splitter
- 27 Pentaprism
- 28 Condenser Lens
- 29 Two-dimensional PSD
- 31, 32, 61, 62 Tilt sensor
- 33 63 Beam shaft controller
- 35 53 Control section
- 41 42 Abbreviation parallel glass
- 43 Covering
- 44 Solution Layer
- 45 46 Glass presser-foot frame
- 45b, 46b Lead screw attaching part
- 47 Pin
- 48 Lead Screw
- 51 Motor
- 52 Motor Gear
- 53 Lead Screw Gear

64 65 Wedge glass  
L1, L2, L3, and L4 Laser beam  
theta Vertical angle

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[Translation done.]

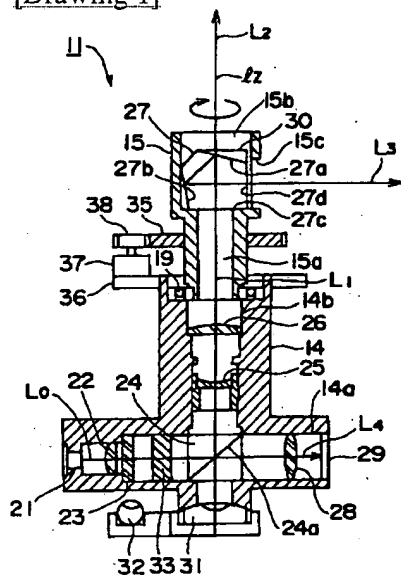
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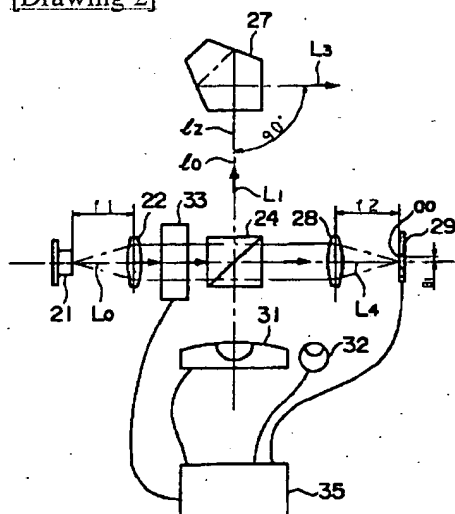
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## DRAWINGS

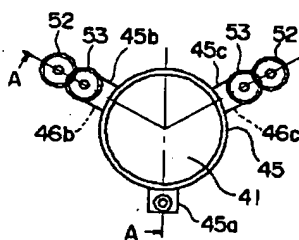
[Drawing 1]



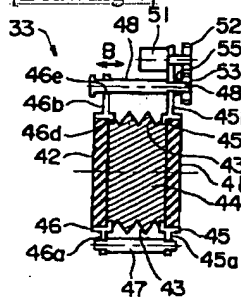
[Drawing 2]



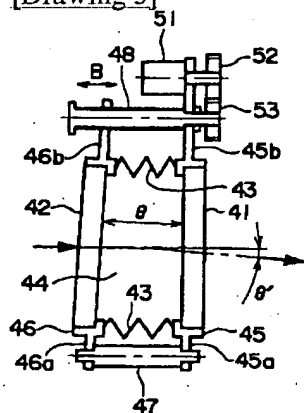
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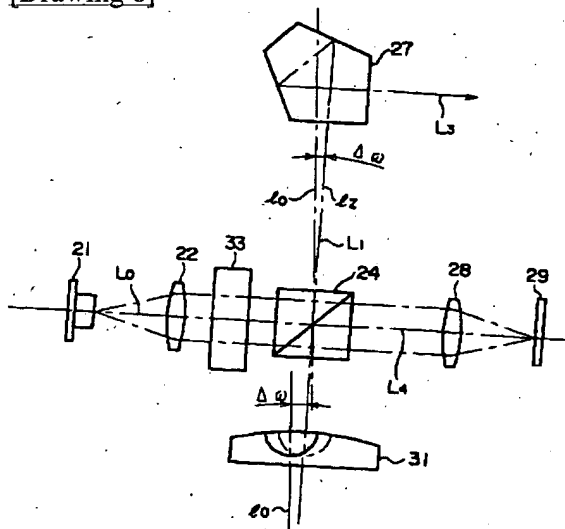
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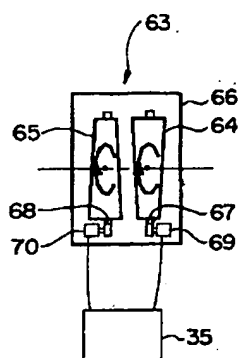
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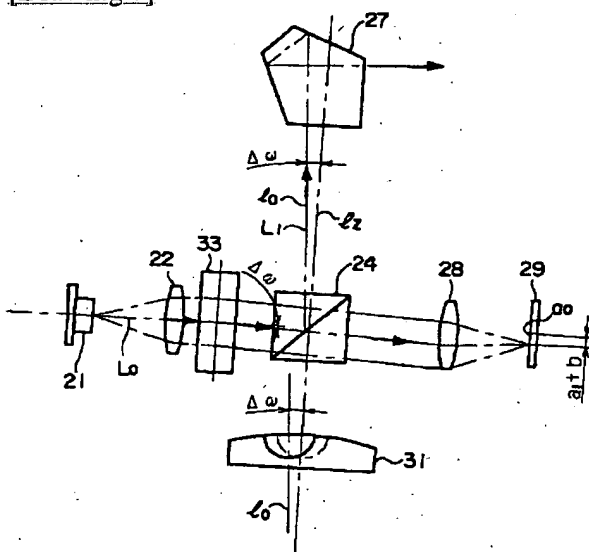
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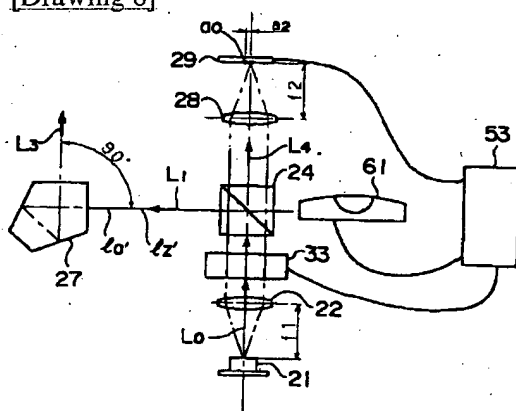
[Drawing 11]



[Drawing 7]

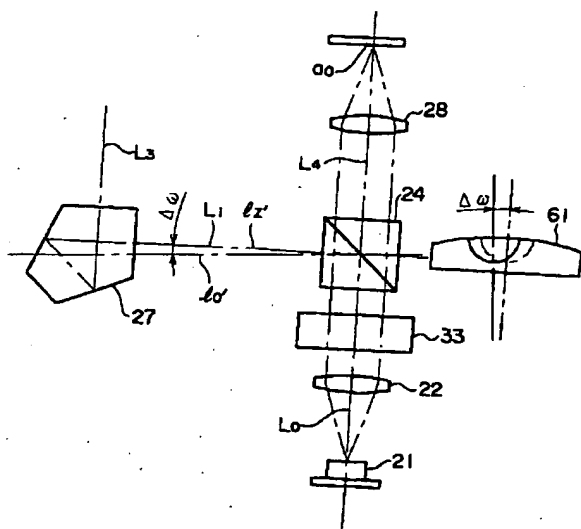


[Drawing 8]

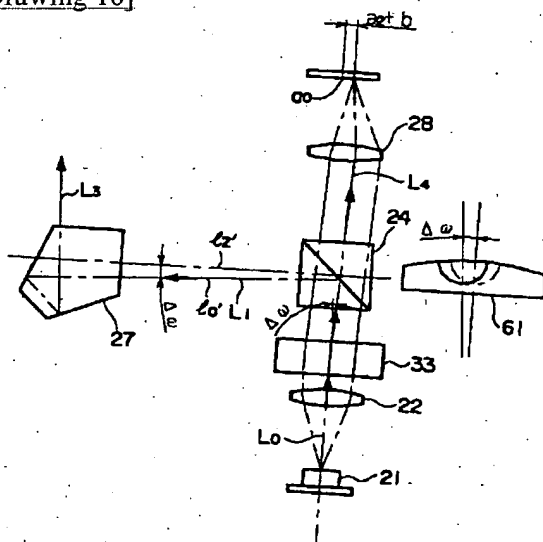


[Drawing 9]

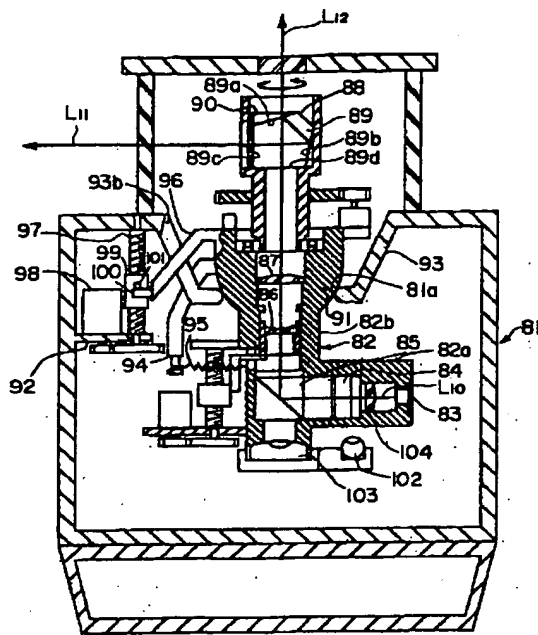




[Drawing 10]



[Drawing 12]



[Translation done.]